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URBANA

BULLETIN NO. 66

# GEOLOGY AND MINERAL RESOURCES
OF THE
# MARSEILLES, OTTAWA, AND STREATOR QUADRANGLES

BY
H. B. WILLMAN AND J. NORMAN PAYNE

With an Introduction to Mineral Resources
BY
W. H. VOSKUIL

A REPORT OF THE AREAL GEOLOGY DIVISION, GEORGE E. EKBLAW, HEAD



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Aerial view of Illinois Valley at Starved Rock

Topographic Mapping in Cooperation with the United States Geological Survey.

This Report is a Contribution of the Areal Geology Division.

September 1, 1941

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# GEOLOGY AND MINERAL RESOURCES
# of the
# MARSEILLES, OTTAWA, and STREATOR QUADRANGLES

By

H. B. Willman and J. Norman Payne

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## CHAPTER I—INTRODUCTION

By

H. B. Willman

### LOCATION AND EXTENT

The Marseilles, Ottawa, and Streator quadrangles are located in the north-central part of Illinois about 50 miles southwest of Chicago and comprise about half of LaSalle County and small parts of Livingston, Grundy, and Kendall counties (fig. 1). The quadrangles are units used in the systematic topographic mapping of the United States. They are bounded by parallels of latitude and meridians of longitude, are approximately 17¼ miles long and 13 miles wide, and have an area of about 225 square miles.

### IMPORTANCE OF THE AREA

The development of extensive deposits of silica sand, coal, clay, shale, sand, gravel, and other mineral resources has long been an important industry in the upper Illinois Valley area, particularly in the Marseilles-Ottawa-Streator area. The undeveloped mineral resources are ample not only to maintain the present industry but under favorable economic conditions to warrant further expansion. The area is an important source of minerals and mineral products for the Chicago market to which it has direct transportation facilities by rail, highway, and waterway.

The scenery of the region is unexcelled in northern Illinois, and typical portions of its most attractive areas have been set aside in State parks. Starved Rock, Buffalo Rock, and Illini State Parks and the Illinois and Michigan Canal State Parkway provide recreational facilities that attract increasingly large numbers of visitors. Many geological features are exceptionally well exposed in the parks and attract the attention of all visitors.

Geologically the area is one of the most interesting in northern Illinois because of its location at the margin of the Illinois coal basin, its position on one of the major bedrock structures of Illinois, the excellent exposures of rock strata along the valleys of Illinois, Fox, and Vermilion rivers, and the interesting succession of events which took place during the glacial period.

Because of the numerous rock outcrops and the development of the mineral deposits, many people in the area have a more than common acquaintance with rocks and minerals and a general interest in geologic problems.

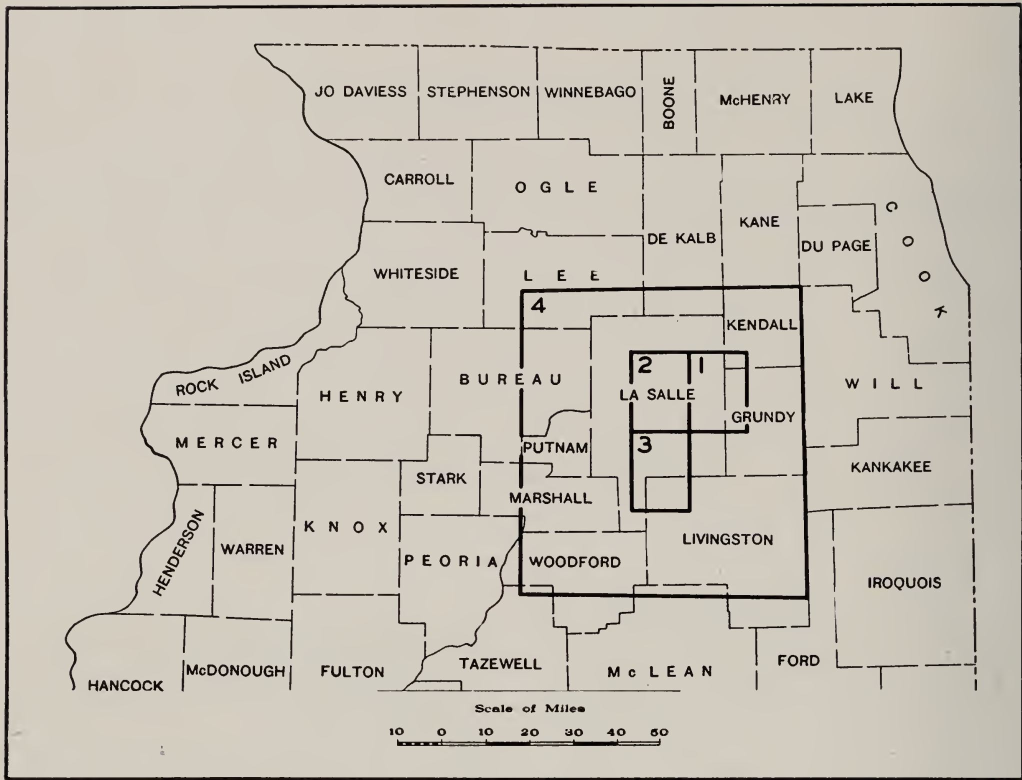


Fig. 1.—Location of the Marseilles (1), Ottawa (2), and Streator (3) quadrangles, and that part of north-central Illinois (4) included in the description of the subsurface stratigraphy and structure.

## PURPOSE OF THE REPORT

This report and the accompanying maps present fundamental geological information about the area, describe its mineral resources, and interpret the geological information for landowners interested in the possible presence of coal and other mineral deposits, the approximate depth to water-bearing formations, and similar information about the rocks which underlie their properties; for mineral producers interested in determining the possibilities for expansion and in prospecting for materials of economic value; for engineers interested in locating and estimating costs of roads and other structures and in finding sources of materials for many types of construction; for geologists and other scientists working in related fields; and for teachers of geology and commercial geography. For the benefit of people interested in collecting rocks, minerals, and fossils, lists of the best collecting localities are given in appendix K.

## HISTORY OF THE INVESTIGATION

This report incorporates the results of investigations of several geologists of the State Geological Survey who at different times have studied various phases of the geology of the Marseilles, Ottawa, and Streator quadrangles. Study of the Ottawa quadrangle was begun in 1917 by Dr. G. H. Cady, assisted first by Mr. H. F. Crooks and later by Mr. L. W. Currier. Dr. Cady mapped the major part of the quadrangle before he resigned to undertake research abroad. In 1922 the project of completing the Ottawa and mapping the Marseilles quadrangles was undertaken by Mr. Currier, assisted by Mr. F. H. Monroe, Jr. Mr. Currier completed the mapping of the quadrangles but because of illness was not able to complete a report until 1930.

Meanwhile many advances had been made in the classification and interpretation of Pennsylvanian and Pleistocene deposits. In 1929 and 1930, Mr. H. B.

Willman, studying the mineral resources along the upper Illinois Waterway under the direction of Mr. J. E. Lamar, revised the Pleistocene and Pennsylvanian stratigraphy of the area near Illinois Valley, and in 1930 Messrs. H. A. Sellin and Victor H. Jones, participating in a state-wide study of road materials directed by Dr. George E. Ekblaw, mapped the Pleistocene deposits farther from the valley. These findings led to a restudy in 1931 of the Ottawa and Marseilles quadrangles by Dr. Willman, under the direction of Dr. Ekblaw, who had been made head of the Areal Geology Division of the Survey. In 1932 and 1933 Mr. L. C. Robinson, assisted at various times by Messrs. Bert Millington, Robert Beck, and Joseph H. Mills, mapped the Streator quadrangle and prepared a report which was used as a doctor's thesis at the University of Chicago. In 1934 Dr. W. C. Krumbein collected records of water wells in the Marseilles and Ottawa quadrangles and on the basis of these data revised the map of the bedrock surface.

The task of preparing one report on the geology and mineral resources of the Marseilles, Ottawa, and Streator quadrangles was assigned to Dr. Willman in 1935. This necessitated minor revisions of the mapping and redescription of many of the geologic sections in the Streator quadrangle. Study, description, and interpretation of the unexposed formations in a large area in north-central Illinois, including the three quadrangles, was assigned to the Subsurface Division of the Survey under the direction of Mr. L. E. Workman. Examination of available sets of samples of well-cuttings was begun by Mr. Harry X. Bay and was completed by Mr. J. Norman Payne, who worked out the subsurface stratigraphy, structure, and history, and prepared a report which he submitted as a doctor's thesis at the University of Chicago and which is incorporated as separate chapters in this report. Dr. W. H. Voskuil prepared the introduction to the chapter on mineral resources.

## ACKNOWLEDGMENTS

The final investigations whose results are presented in this report and the report itself were made under the direction of Dr. Ekblaw, geologist and head of the Areal Geology Division of the Survey, with whom the writers have counseled throughout their work on the project. Full access was had to the notes and field maps of previous workers, named above under the history of the investigation. In preparing the report the writers benefitted from the counsel of Dr. M. M. Leighton, Chief of the Survey, on the report as a whole, of Drs. Leighton and Ekblaw on the Pleistocene stratigraphy, of Drs. Cady and J. Marvin Weller on Pennsylvanian stratigraphy, of Mr. L. E. Workman and Dr. Ekblaw on the subsurface stratigraphy and structure and on water resources, of Dr. Cady on coal resources, of Mr. J. E. Lamar on silica sand, clay, gravel, and limestone resources, and of Dr. A. H. Bell on the possibilities of oil and gas production. Dr. Weller identified the Pennsylvanian fossils and Dr. J. S. Templeton the Ordovician fossils. The aerial photographs were furnished by the Illinois Agricultural Conservation Committee.

Mineral operators, well drillers, and other citizens of the area have rendered many courtesies and much valuable assistance. Mr. F. H. Renz, City Engineer of Streator, particularly, gave much information about the Streator coal field.

The writers have made frequent use of the field notes and reports of the earlier workers but have made many changes in interpretation and accept responsibility for all the statements made.

## PREVIOUS PUBLICATIONS

The first publications treating the geology of the Marseilles-Ottawa-Streator area comprehensively are those of the original Geological Survey of Illinois[1] under the direction of A. H. Worthen, as follows:

Grundy County, by Frank H. Bradley, Geol. Survey of Illinois, vol. IV, pp. 190-206, 1870.

Kendall County, by H. M. Bannister, Geol. Survey of Illinois, vol. IV, pp. 136-148, 1870.

[1] Out of print. Consult public, technical, or university libraries.

Livingston County, by H. C. Freeman, Geol. Survey of Illinois, vol. VI, pp. 235-244, 1875.

LaSalle County, by H. C. Freeman, Geol. Survey of Illinois, vol. III, pp. 257-287, 1868.

Notes on LaSalle County, by A. H. Worthen, Geol. Survey of Illinois, vol. VII, pp. 39-51, 1883.

Economical geology of Illinois, by A. H. Worthen and assistants, Geol. Survey of Illinois, 3 vols., 1882. (Contains reprints of above county reports with minor additions and emendations.)

Despite the fact that this work was done nearly 80 years ago, the general distribution and correlation of the geological formations were determined with remarkable accuracy and the reports are still valuable references.

Numerous additional publications relating to the geology of the area have been published by the present Illinois Geological Survey. Several of these are studies of the mineral resources of the State and include references to clay, coal, limestone, and silica sand in the local area. These references are cited under the description of the materials. Other reports which include descriptions of parts of the area are as follows:

Geography of the upper Illinois Valley and history of development, by Carl Ortwin Sauer, Illinois State Geol. Survey Bull. 27, 1916.

Starved Rock State Park and its environs, by Carl O. Sauer, Gilbert H. Cady, and Henry C. Cowles, Geographic Society of Chicago, Bull. 6, 1918.

Detailed reports similar to the present one have been published for quadrangles adjacent to the Marseilles and Ottawa quadrangles as follows:

Geology and mineral resources of the Hennepin and LaSalle quadrangles, by G. H. Cady, Illinois State Geol. Survey, Bull. 37, 1919.

Geology and mineral resources of the Morris quadrangle, by H. E. Culver, Illinois State Geol. Survey Bull. 43B, 1922.

Since the above studies were completed, several changes have been made in the conceptions of Pennsylvanian and Pleistocene stratigraphy, and as a result their treatment and interpretation of these strata do not agree with the present report in some respects.

In addition to the above publications, references to the area are included in many of the present Illinois Survey reports, and a number of short articles on various phases of the geology of the area have been published in scientific periodicals.

# CHAPTER II—TOPOGRAPHY

By

H. B. Willman

## INTRODUCTION

The Marseilles-Ottawa-Streator area lies in the heart of "rolling" prairies, consisting of upland plains with gentle swells and shallow depressions, occasionally interrupted by low broad ridges which rise above the plains. In striking contrast to the broad vistas of the unforested prairie uplands, the valleys have steep walls and many of them are picturesque canyons to which hardwood forests add scenic charm.

*Physiographic province.*—Topographically the area is typical of a large part of Illinois, Indiana, and Ohio that, in the physiographic classification of the United States, is included in the Till Plains section of the Central Lowland province[1] (fig. 2). The Till Plains section is characterized by a widespread mantle of glacial drift, mostly in a youthful stage of topographic development. The section is differentiated from the older till plains to the west which are much more dissected and from the younger till plains to the north which are very slightly eroded and abound in undrained depressions containing lakes and swamps.

*Elevation.*—The highest elevation in the area is along the crest of the Marseilles moraine north of Marseilles, where 14 hills are more than 780 feet but less than 800 feet above sea-level. Two areas, each covering about five acres in secs. 2 and 3, T. 34 N., R. 5 E. (Miller Twp.), Marseilles quadrangle, have an elevation exceeding 780 feet. The lowest point in the quadrangles is the bed of Illinois River at the west margin of the Ottawa quadrangle, where the low-water level is a little below 445 feet above sea-level.

[1]Fenneman, N. M., Physical divisions of the United States, map in Physiography of Western United States, McGraw-Hill, N. Y., 1931.

*Relief.*—The maximum relief of the quadrangles, or the difference in elevation between the highest and lowest points, is approximately 345 feet. The greatest local relief occurs at Marseilles, where points on the upland about two miles from Illinois River are 290 feet above the river. Steep valley-walls 160 feet high occur at several places along Illinois Valley, and the north face of Starved Rock is an essentially vertical cliff 125 feet high.

The areas of least relief occur in the upland along the east margin of the Marseilles quadrangle north of Illinois Valley, along Vermilion Valley south of Streator, and north of Illinois Valley at Ottawa. In the last area there are 10 land-sections (square miles) shown on the topographic map entirely without contours, indicating a relief of less than 20 feet.

Topographic profiles across the area are shown in figure 3.

*Topographic maps.*—The topography of the area is shown on the topographic maps which serve as the base for the geologic and economic maps (pls. 1-6). The maps show *relief* (variations in the elevation of the surface) by brown contour lines, *water* (rivers, streams, lakes, swamps, and canals) in blue, and *culture* (the works of man, such as towns, highways, railroads, and land boundaries) in black.

Each of the brown contour lines indicates the position on the ground of an imaginary line on which every point is at the same elevation above sea-level. The interval between the contour lines is uniform over each of the maps, 20 feet for the Ottawa and Marseilles maps and 10 feet for the Streator map. To assist in the identification of the contours every fifth contour line is printed heavier than the others. By studying the position of

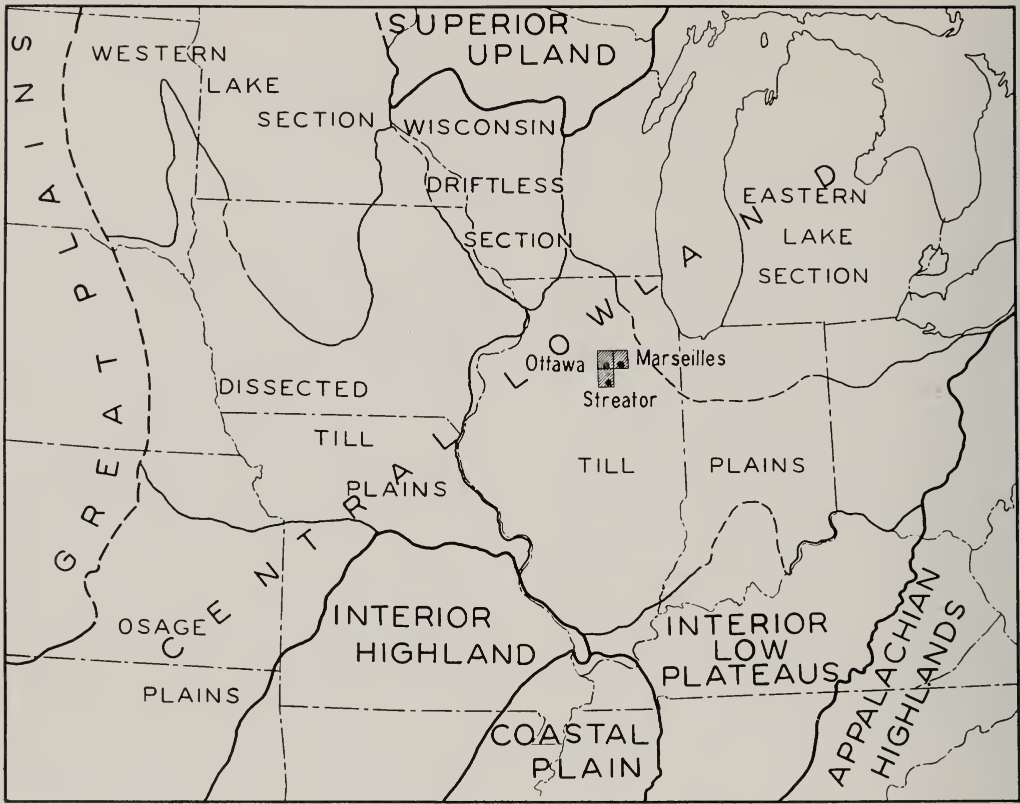


Fig. 2.—Physiographic divisions of the Middle West, showing location of the Marseilles, Ottawa, and Streator quadrangles. (After Fenneman.)

the contours it is possible to determine the elevation of any point in the area with an error not exceeding that of the contour interval. The relative steepness of slopes may be readily perceived, as the closer the contours the steeper the slope, and at vertical cliffs, as in Starved Rock State Park, the contours converge into a single line. Detailed instructions for the interpretation of topographic maps are printed on the backs of the standard topographic maps.

## GEOLOGIC FACTORS

The present topography of the Marseilles-Ottawa-Streator area has developed through many thousands of years during which the dominant processes have varied from time to time. The topography of the earth's surface is modified by processes acting from within the earth and by processes controlled by the atmosphere. Internal processes, such as volcanism and diastrophism, probably important at times in the geologic past, have not been important in the development of the present topography of this area. The variations of the atmosphere in temperature, precipitation, wind, etc., comprise the climate, and climate controls the external processes molding the surface of the earth, be they erosion or deposition by streams, glaciers, lakes, or winds. Although much of the present topography is inherited from glacial times, in many respects the glacial climate was probably not greatly different from that of the present. Moreover, the present climate controls processes which, although modifying the surface very slowly from the viewpoint of human history, will probably greatly reshape the present contours of the land in a relatively short interval of geologic time.

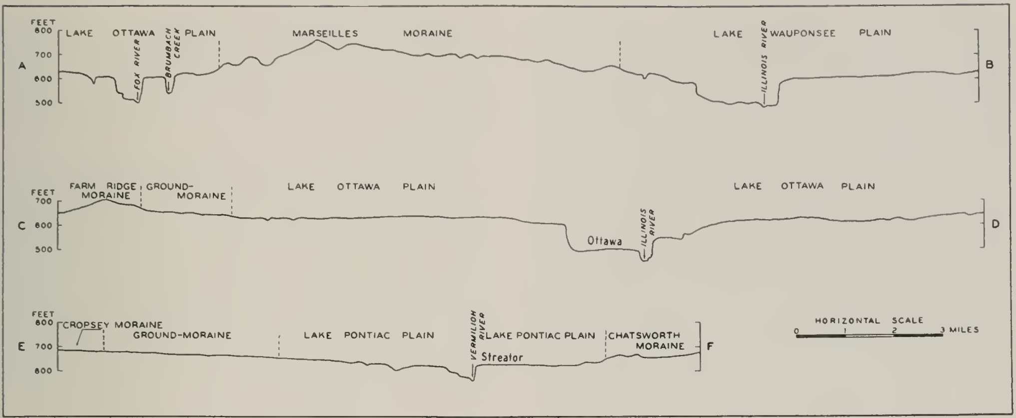


FIG. 3.—Topographic profiles across the Marseilles, Ottawa, and Streator quadrangles at locations shown on plates 4, 5, and 6.

## CLIMATE

The climate of the Marseilles-Ottawa-Streator area is typical of much of the Temperate Zone—warm summers when the sun is at a high latitude and gives a maximum of about 15 hours of sunshine, and cold winters when the sun is comparatively low and the minimum day is only nine hours long. The climate does not react immediately to the sun's changes in latitude. The sun reaches its highest latitude on June 21st, but the peak of temperature is reached in July, and in general the seasons lag about a month behind the sun. The many variations in the climate are well shown in the climatological data collected by the United States Weather Bureau at stations within the area and in nearby areas (app. E).

### Temperature

The mean temperature of the area, based on records at Ottawa, Pontiac, and Minonk for 38 to 48 years, is 50-52° F. The mean temperature for each of the three summer months is fairly uniform as it is also for the three winter months (app. E, table 7). Between these seasons the temperature varies progressively with an average change of about 10 degrees each month. The mean temperature for the winter months (December, January, February) is 27° F., for spring (March, April, May) it is 50°, for summer (June, July, August) it is 73°, and for fall (September, October, November) it is 53°. At Ottawa the average date of the last killing frost in spring is April 30 and of the first killing frost in autumn is October 11, giving an average growing season of 164 days (app. E, table 8).

The daily variation in temperature is at times as much as 40° F. and not uncommonly as little as 5°. The average daily variation is about 22 degrees but is somewhat greater in summer (25° in July) than in winter (16° in December). In contrast unusual extremes of temperature are more likely in winter than in summer, as shown by the range of extremes of about 68° in summer and 94° in winter (app. E, table 7). The great variation in temperature not only from day to day but from year to year is shown on the charts of daily extremes for two consecutive years (pl. 7). On February 22, 1936, the minimum temperature was −11° and the maximum 29°, while the following day the variation was from 25° to 44°, and on the next day 39° to 57°. A sub-zero cold wave with temperature continuously well below freezing invaded the area during late January 1936, but during the same time in 1935 the temperature was persistently above freezing.

The temperature of the air has an important effect on topographic development. Warm weather facilitates some weathering processes which loosen rock materials, thus accelerating erosion and transportation of the rock fragments. High temperature also favors evaporation of water from land and ocean, and the water precipitated on the land is an effective agent of erosion. The water is reevaporated and thus used over and over in the cycle of stream erosion. In spring the warm air frequently melts the snow and ice rapidly and, if accompanied by rains, results in floods that are especially effective in erosion. The effect of melting snows on the discharge of Illinois, Fox, and Vermilion rivers may be seen by a comparison of plates 8, 9, and 10. Periods of high discharge in the rivers, although unaccompanied by heavy precipitation, coincide with periods of temperatures above freezing. Contrarily, warm weather also encourages growth of plants, which tends to check erosion.

A sufficiently cold climate causes the formation of ice which is an active agent in the disruption of rocks. If long continued and accompanied by sufficient precipitation, a cold climate may result in the formation of glaciers which by both erosion and deposition modify the topography. Also a cold climate facilitates erosion by hindering plant growth. The movement of buried boulders to the surface of the ground because of frost action is a phenomenon frequently observed but is only a minor factor in topographic development.

### Precipitation

Much of the moisture precipitated in the area is derived from the Gulf of Mexico and is carried into the region by air masses of relatively low pressure, known as *cyclones*, which, alternating with air masses of relatively high pressure, called *anticyclones*, cross the Middle West from southwest to northeast. These air masses move at somewhat variable speeds but the cyclones usually cross the area about one week apart. Precipitation is of two types—the general rains which usually cover the entire area with comparatively slow precipitation lasting at times for several days, and the thunderstorms which occur principally in the summer and are short-lived, cover small areas, frequently give heavy precipitation in a short time, and may be accompanied by high winds. The local effect of thunderstorms can be seen by a comparison of the precipitation records and river discharge data (pls. 8, 9, 10). Many sudden rises in Fox River have no comparable rises in Vermilion River. The total precipitation averages fairly even over a long period but during especially dry summers the more or less accidental courses of the storms may result in one part of the area having a considerably higher or lower precipitation than another part.

The annual precipitation of the area averages approximately 32 inches, and rainfall is generally somewhat higher in summer than in winter (app. E, table 1). The average monthly precipitation is between 3 and 4 inches from May to September, inclusive, and from 1 to 3 inches during the remainder of the year. The precipitation is characterized, however, by great variations, and its inconsistency is shown by the fact that the maximum recorded for every month exceeds the average of the wettest month, and the minimum for every month is less than the average for the driest month (app. E, tables 1-3). Also the precipitation for a 24-hour period may exceed the monthly average (app. E, table 9). The greatest monthly precipitation recorded is 14.28 inches, and the minimum is a trace. Precipitation during the winter is partly in the form of snow, which falls mostly in the months from November to April with traces in October and May (app. E, table 6). Even in winter much of the precipitation is in rain. The records of monthly precipitation at Streator and Ottawa are given in appendix E, tables 4 and 5.

The water precipitated in the form of rain and snow is the principal factor in the modification of the present topography. The rain and melted snow is concentrated in rivulets, streams, and rivers which erode their channels, especially during times of flood. The development of gullies of considerable size during a single heavy rain is not uncommon, and there are many examples of recent erosion along the major streams and rivers.

### Wind

The predominant direction of the wind is from the southwest except during winter when it shifts to the northwest (app. E, table 9). However, the direction of the wind varies frequently because of the progression of the cyclones and anticyclones across the area. In general the air rotates in a counter-clockwise direction about the central parts of the cyclones and clockwise about the anticyclones, with a general movement into the cyclones and outward from the anticyclones.

Indirectly the wind is an important factor in topographic development as it carries into the area the large quantities of moisture which fall as rain. The direct effect of the wind is less conspicuous although its ability to move large masses of material is demonstrated by the occasional dust storms and the local presence of dunes of sand.

## TOPOGRAPHIC PROCESSES

The predominant processes in the development of the topography of this area have been glacial, stream, lake, and wind action. The preglacial topography was produced almost entirely by stream erosion but it was completely concealed by deposits of the glaciers. Much of the glacial topography has been modified by running water. During the recession of the glaciers the rivers were fed with torrents of water from the melting ice and were more capable agents of erosion and transportation than the present streams. Stream erosion, although at a reduced rate, has been continued to the present. In addition large areas of glacial topography were modified during glacial time by the presence of extensive lakes. The topographic history of the area is discussed under geological history, especially the Pleistocene history (pp. 205-230).

### Streams

Erosion of the valleys has been accomplished by running water but the process is so slow that within the memory of man few important changes in the valleys have occurred. Occasionally the erosive power of the streams is evident at times of flood, when a bank with some recognizable marker as a fence or a tree is washed away. By far the greater part of the erosion of the rivers and streams has been accomplished in times of flood when the power of transportation is greatly augmented by increased velocity and volume.

*Base-level.*—The rate of erosion of the valleys gradually decreases as the valleys are cut down, for when the gradient of the streams is lowered, their velocity and transporting power are reduced. The streams can erode only as deep as will leave them sufficient gradient to flow, and they obviously cannot erode below the level of their mouths. This applies not only to the major rivers but to every stream and the smallest rivulet. Illinois River cannot erode below the level of Mississippi River, and Fox River cannot erode below the level of the Illinois. The streams above the dam at Dayton cannot erode lower than the level of the lake formed by the dam, as long as the lake is present. The depth to which running water may erode is called the *base-level.* Because the rocks in some parts of the area are much more resistant to erosion than in other parts, the streams are at different stages in the task of eroding their valleys to base-level. For example, the streams in Starved Rock Park with waterfalls a short distance above their junction with Illinois River are cutting in bedrock and are far above their base-level. On the other hand many streams in unconsolidated glacial materials near Seneca have eroded down to the level of Illinois Valley in the lower parts of their courses and are widening their valleys by lateral cutting. However, in both illustrations the streams still have a great deal of erosion to accomplish before their entire drainage areas are reduced to their base-levels.

*The erosion cycle.*—When any land area is uplifted the base-level of the streams is lowered, erosion is accelerated, and an *erosion cycle* is started. During the early part of an erosion cycle the streams erode steep-sided valleys. Large parts of the area are unaffected and so have the same topography as at the time of the uplift. Little of the entire area has been eroded and it is said to be in a *youthful* stage of the erosion cycle. As erosion proceeds, branches of the streams erode headward, gradually penetrating to all parts of the area. By the time the original surface of the area is nearly all dissected some of the major streams have started widening their valleys by lateral planation, the area is well drained, and relief is at its maximum. A large part of the entire erosion of the area to base-level has been accomplished and the area is said to be in the *mature* stage of the erosion cycle. With continued erosion by the streams, lateral cutting becomes more important and eventually the area may be reduced to a surface of low relief. The streams have cut to base-level and the area is in the *old* stage of the cycle. If the area is uplifted again the process will be repeated. Interruptions of the cycle may occur at any time; further uplift accelerates the cycle, or rejuvenates it, while sinking slows it down and perhaps halts it and reverses the process from erosion to deposition.

The Marseilles-Ottawa-Streator area, with broad uplands cut by narrow steep-walled valleys, is in the youthful stage of the erosion cycle. Although the major streams and rivers have cut deep channels, erosion of the area to its base-level would require removal of many times the volume of material which has been eroded. The present cycle of erosion was begun, not by the uplift of the area with relation to sea-level, but by glacial deposition which filled the valleys and raised the surface about 150 feet. Before glaciation, the area was in a late youthful stage of erosion and the bottoms of the major valleys were slightly below those of the present valleys.

*Formation of terraces.*—Erosion of the valleys has not always proceeded at a uniform rate. Layers of hard rock have been encountered by the streams, and erosion at the levels of these layers has either left benches of the hard layers along the valley-walls or waterfalls in the channels. Variations in the rate of erosion were frequent during glacial times when the major valleys carried water from the melting ice. Changes in the rate of melting or shifting of the ice-front resulted in fluctuations of the volume of water in the rivers. At times the rivers eroded their channels actively but at others they deposited their loads of sand and gravel, thus aggrading their valleys. When erosion began again the previous deposits were largely removed, but in protected places remnants were left in the form of terraces which are called *depositional terraces* because the surface of the terrace represents the level to which deposition built the valley-floor. Where the rivers eroded broad channels in bedrock or glacial materials and erosion was then further accelerated, the rivers cut new channels in the old river bottom, remnants of which remained as terraces. As the surfaces of these terraces represent levels produced by erosion, they are referred to as *erosional terraces*. By repetition of these events several terraces have been formed along many of the valleys in this area.

### Glaciers

The glaciers which several times covered this area probably eroded the underlying materials to various degrees but any distinctive features produced by erosion were later concealed when the melting ice deposited materials with varying topographic forms. The many features of glacial deposition are described under stratigraphy (pp. 142-144).

### Lakes

Although the only lakes in the area are artificial, large lakes covered parts of the uplands during Pleistocene time. Their main effect was to level the surface on which they lay. Currents and waves eroded the higher areas and deposited the eroded material in low places in the lakes. The lakes were so short-lived that they did not completely eradicate the glacial topography and they had such unstable levels that no distinctive shore features were formed.

### Winds

Wind has been a comparatively unimportant factor in the development of the topography in the Marseilles-Ottawa-Streator area. The widespread mantle of wind-blown loess has slightly reduced the relief in the morainal areas. In a few small areas the wind has heaped sand into dunes.

### Activities of Man

Man has become an important factor in the topographic development of the area, especially in alteration of the natural drainage. Lakes have been formed by the construction of dams along Illinois, Fox, and Vermilion valleys for navigation, for power, and for municipal water supplies; the Illinois and Michigan Canal was dug, and water to feed it was diverted from Fox River; the low-water flow of Illinois River was increased manyfold by diversion of water from Lake Michigan; many swamps and even lakes have been drained by ditches and tile drains.

Indirectly man has influenced the drainage of the area by cutting the forests. The forests were confined largely to the valley-slopes but in this position they were effective in retarding the run-off following rains. The accelerated run-off has caused gullying of many slopes, has increased the erosive power of many streams so that they have entrenched themselves in their former valley-flats, and has raised the peaks of flood waters. The extent of removal of the forests may be determined approximately by comparison of the topographic maps showing the present forests with Soil Survey maps showing the area covered by forest types of soil.

Industrially man has altered the natural topography by digging quarries and open-pit mines and by accumulating waste-piles at mines and factories. Subsidence of the surface in areas where thick coals have been mined near the surface has produced sinkholes (figs. 4, 29). In the development of transportation facilities many cuts and fills have been made for railroads and highways.

Fig. 4.—Sinkholes formed by collapse of mine roof. The mine dumps in the background are at the abandoned Heenanville mines. View north from near Vermilion River a quarter of a mile east of Klein Bridge, NW. ¼ SW. ¼ SW. ¼ sec. 10, T. 31 N., R. 3 E. (Bruce Twp.), Streator quadrangle.

## DRAINAGE

The rainfall in the area supports a widely branched system of closely spaced streams and three rivers, the Illinois and two of its large tributaries, Fox and Vermilion (fig. 5). Swampy tracts are common in the morainic areas of the uplands and also in the bottomlands of the larger valleys. Large artificial lakes occur along Illinois, Fox, and Vermilion valleys.

About 25 per cent of the precipitation, which averages 32 inches per year, flows from the area by way of the streams and rivers and about 75 per cent sinks into the ground or escapes by evaporation. Were it not for the rainfall which sinks into the ground and is later slowly released as springs and seepage along the valleys, most, if not all, of the streams and rivers would completely dry up during many of the long intervals in which rainfall is slight. During a long-continued dry interval the total amount of groundwater is reduced by gradually escaping into the valleys, and the *water-table*, the top of that part of the ground saturated with water, sinks lower and lower. When the water-table sinks below the bottom of a stream valley, the stream goes dry, first in the headwaters and then farther down the valley. Protracted droughts greatly reduce even the master streams which carry drainage from large areas. Vermilion River at Streator, for example, has gone dry or become stagnant on several occasions. On the topographic maps the streams which are frequently intermittent are indicated by broken lines and the more permanent streams by solid lines. Many of the latter are intermittent at times.

### DRAINAGE PATTERN

The heavy rainfall of the area is reflected in the abundance of streams which form an irregular network throughout the area (fig. 5). The lack of uniformity in the pattern produced by the streams is characteristic of streams developed on the irregular surface of glacial drift. In part of the area the streams form a widely branching dendritic or treelike pattern, simulating that developed on flat surfaces in horizontal bedrock, and in others they have a parallel or trellis pattern suggestive of areas of folded bedrock. Although many of the streams cut into bedrock, the pattern of the streams is controlled by the distribution of the hills and depressions on the glacial drift, and the bedrock has only a minor influence on the position of the streams.

Many of the streams have tortuous channels which wind a mile to advance half that distance or even less, as is well shown by Prairie Creek, three miles west

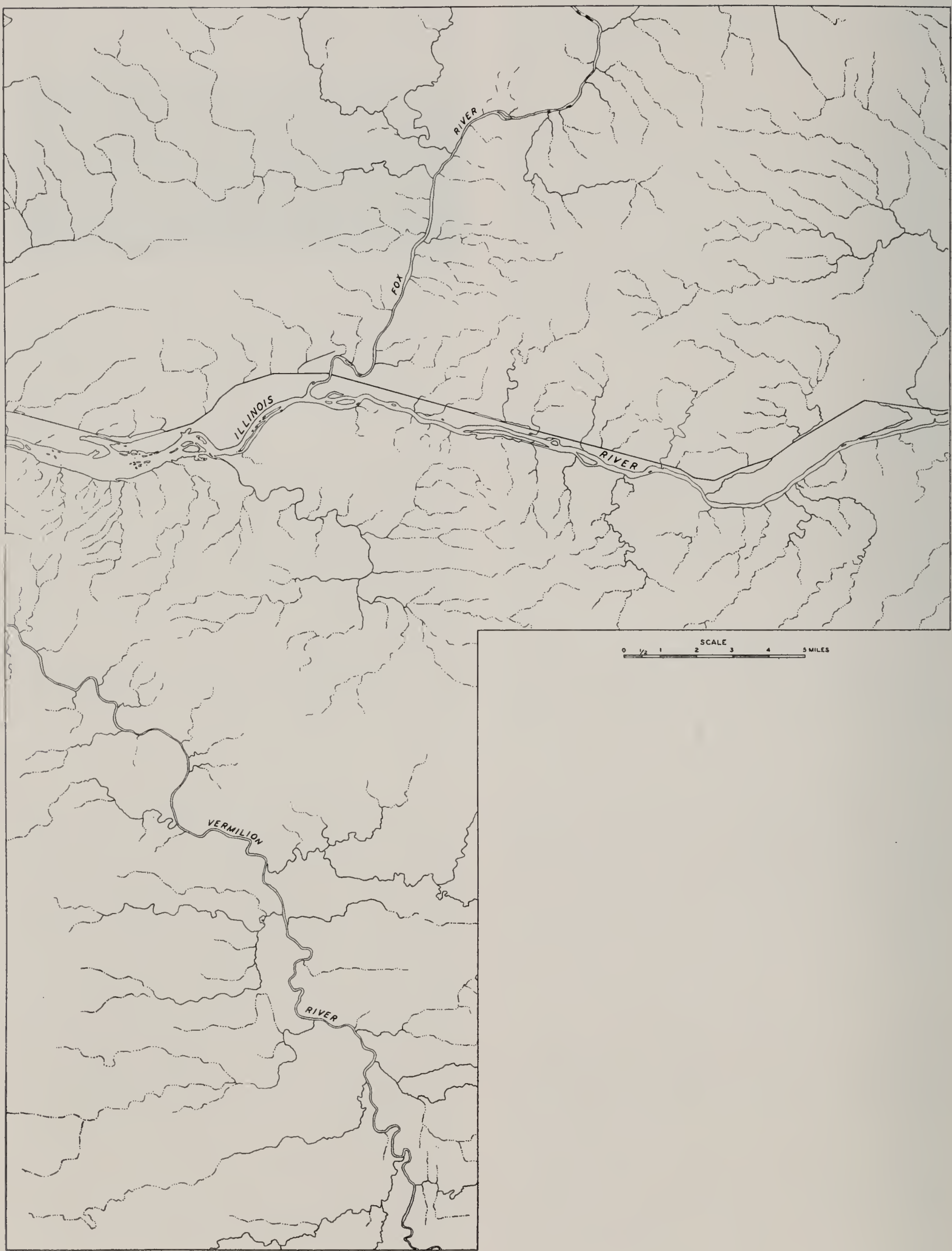


FIG. 5.—Drainage pattern of the Marseilles, Ottawa, and Streator quadrangles.

of Long Point, and by Walbridge Creek, two miles northwest of Marseilles. Even the rivers show a definite relation to the distribution of the drift. Fox and Vermilion rivers flow parallel to morainic ridges by which their courses were determined, and although Illinois Valley crosses the morainic ridges, its relation to bedrock structure and the preglacial drainage system (fig. 88) indicates that its position was determined by the glacial deposits.

## RIVERS

### Illinois River

Illinois River, which drains about half of Illinois, and whose branches extend northward into Wisconsin and eastward into Indiana, carries the run-off from all the Marseilles-Ottawa-Streator area. It crosses both the Marseilles and Ottawa quadrangles and a short distance west of the Ottawa quadrangle receives most of the drainage from the Streator quadrangle. At Starved Rock it carries the natural drainage from about 10,300 square miles. However, not since 1900[2], when water from Lake Michigan was diverted into DesPlaines and thence to Illinois River, has it carried only the normal run-off of its drainage basin. The river has a comparatively straight course, as it flows only 29 miles in traversing the 26½ miles across the Marseilles and Ottawa quadrangles.

*Gradient.*—Because of the waterway dams built across Illinois River at Marseilles and Starved Rock, the present gradient of the river is decidedly different from its natural gradient. Before the dams were constructed, the low-water level of the river was about 485 feet above sea-level at the east margin of the Marseilles quadrangle and about 445 feet at the west margin of the Ottawa quadrangle, a descent of 40 feet. The average gradient of the river, therefore, was about 1.4 feet per mile. However, much of the descent of the river occurred at the rapids at Marseilles (fig. 6) where the river dropped about 18.6 feet in a distance of 1.5 miles, giving it a gradient of 12.4 feet per mile for that distance. Above the rapids the average gradient was only 0.6 foot per mile and below the rapids it was 1 foot per mile, even including the less conspicuous rapids at Starved Rock. West of the Ottawa quadrangle the river flattens perceptibly and it lowers only 28 feet in the remaining 236 miles to its junction with Mississippi River, an average gradient of 0.12 foot per mile for that distance.

Fig. 6.—View of the rapids in Illinois River at Marseilles at low water, showing the characteristic orientation of the large slabs of rock with their surfaces dipping upstream (left).

*Flow.*—Previous to the diversion of water from Lake Michigan, Illinois River at Ottawa is reported[3] to have had from 1890 to 1899 an average flow of 697 second-feet[4] for the three driest months, an ordinary discharge of 2,369 second-feet, and an average for the three wettest months of 13,180 second-feet. At extreme low water the river had a flow of only 250-350 second-feet. From January 1, 1936, to December 31, 1938, the amount of water diverted from Lake Michigan was limited to an annual average of 5,000 second-feet, but by court order the diversion was reduced to an annual average of 1,500 second-feet after January 1, 1939.

The influence of the diversion waters on the flow of the river is shown by the 1919-1935 average discharge of 13,380 second-feet at Morris (app. F) which is nearly six times the average flow at Ottawa before diversion, although the figures are not exactly comparable because of the difference in the location of the gaging stations.

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[2]For about 30 years previous to 1900 there was an intermittent and comparatively small diversion of Lake Michigan water into DesPlaines River.

[3]Leighton, M. O., Pollution of Illinois and Mississippi Rivers by Chicago sewage: U. S. Geol. Survey, Water-Supply and Irrigation Paper 194, p. 159, 1907.

[4]Second-feet is the abbreviation for cubic feet per second (p. 362).

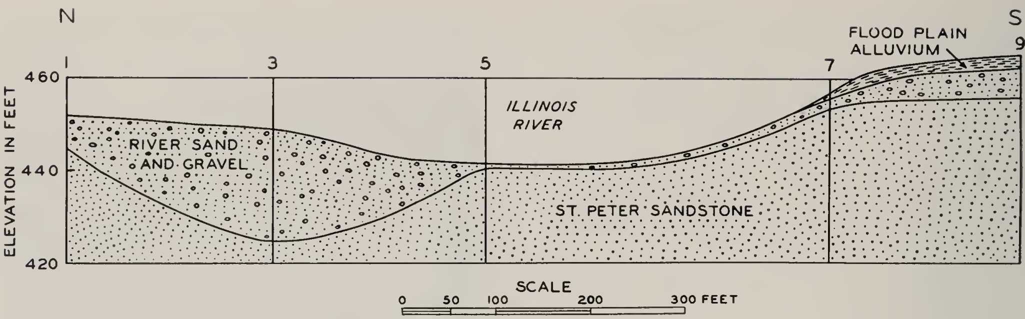



Fig. 7.—Cross-section of Illinois River at Ottawa, showing discordance between the present channel and the deepest part of the bedrock valley.

The diversion especially influenced low-water flow, as before diversion the river had only a gentle current and was almost stagnant at times during the summer, but after diversion had a minimum flow of 5,120 second-feet between 1919 and 1935. During high-water stages the diversion had less effect, as it forms a much smaller percentage of the total flow. A maximum discharge of 62,300 second-feet was recorded at Morris on April 2, 1933, with gage height of 19.1 feet, but it is reported that a stage of 26.2 feet occurred in 1831. The recorded extreme high-water flow of the river is more than 200 times the extreme low-water flow previous to diversion from Lake Michigan.

Because of the irregularity of the rainfall (pl. 8), a flood stage may occur in any month, but records indicate it is less likely to occur from June to September than in the other months. Extreme high water is most probable in the spring when a heavy rainfall may facilitate melting of the snow, and the frozen ground causes a very high run-off. Ice-jams during the break-up in the spring also cause temporary stages of unusually high water.

*Depth.*—The depth of the river varies from place to place, depending on the width and gradient of the channel, both of which are variable. The depth also varies continually as bar deposits are shifted, especially during floods. At Morris the river had a stage of 3.9 feet at its minimum discharge in 1929, but its maximum stage since 1919 was 19.1 feet in 1933. Extreme variations of 20 feet or a little more may be expected over a long period of years.

Except at the rapids at Marseilles, the river forms the channel of the Illinois Waterway in which a minimum depth of 9 feet is maintained. In some areas repeated dredging along the channel is necessary to maintain this depth, especially during the summers of unusually low rainfall such as those of the last few years. In the pools above the dams the river is considerably deeper. When the Ottawa pool is maintained at 460 feet above sea-level the channel depth is about 18 feet.

*Width.*—The river is far from uniform in width. It has numerous expansions, contractions, and divisions into several channels. Before the construction of the waterway dams, the river in the Marseilles and Ottawa quadrangles varied in width from about 350 to about 1000 feet. At present the maximum width of the river is about 4,000 feet about two miles east of the Starved Rock dam. The width of the river naturally increases greatly during floods. With a rise of about 10 feet it overflows the channel and expands over nearly all the islands and most of the narrow floodplain.

*Erosion.*—Borings at Starved Rock, Ottawa, Marseilles, and Seneca show that bedrock underlies a few inches of sand and gravel in the deepest part of the channel. It is probable that the river scours to bedrock during intervals of high water and deposits a thin layer of gravel in the channel when the velocity of the water decreases. At Starved Rock the river has scoured a depression in the bedrock. The channel of the river shifts from time to time, and the deepest part of the present channel does not always coincide with the channel in bedrock, as is shown by borings at Ottawa (fig. 7). By lateral erosion, especially in flood stage, the river maintains steep valley-walls at Starved Rock and Buffalo Rock. A short distance west of the Ottawa quadrangle the surface of the bedrock lowers and the river is about 60 feet above bedrock.

*Material transported.*—Borings in the river show that the principal deposits in the immediate channel of the river are gravel and sand. Some thin beds of clay and silt are locally present along the margins of the channel. The river has a narrow floodplain on which it deposits sand and silt in the flood stages. Silt is deposited especially during the decline of the floods and forms the surface material of most of the floodplain.

During high-water stages the river moves large slabs of rocks in the rapids at Marseilles. The water commonly washes loose material from beneath the upstream edge of the rocks and as a result a large percentage of them are uniformly oriented with their upstream edge lower than the downstream side (fig. 6). This is a characteristic orientation of stream-borne materials, which can be seen on a smaller scale along almost all streams, especially those transporting slabby or disc-like rock fragments.

## Fox River

Fox River flows across the northwest corner of the Marseilles quadrangle and southwest through the Ottawa quadrangle to join Illinois River at Ottawa. Despite a large curve in the Marseilles quadrangle, its course is comparatively direct, as it flows only 16¾ miles in traversing the 13¼ miles between the point where it enters the area and its mouth. The river rises in southeastern Wisconsin, 35 miles north of the Illinois state line, and drains about 2,580 square miles. The natural character of the river has been altered locally by the power dam of the North Counties Hydroelectric Company at Dayton and also by the Starved Rock dam in Illinois Valley which raises the water-level in the lower part of Fox Valley.

*Gradient.*—Fox River enters the area at an elevation of 525 feet above sea-level and had a low-water elevation of about 455 feet at its mouth before the level was raised by the Starved Rock dam. With that descent of 70 feet in a distance of 16¾ miles the river had an average gradient of 4.2 feet per mile, which is twice that of Vermilion River and three times that of Illinois River. The difference in gradients is well shown by the fact that the 460-foot contour crosses Fox River only 1¼ miles above its mouth but it does not cross Illinois Valley until 5¼ miles above the mouth of Fox Valley. The gradient of Fox River is not uniform; the several rapids are separated by areas of low gradient. Before the dam was built at Dayton a rapids half a mile long existed at that place. Variations in the gradient are shown on the topographic map, as the river descends from the 520- to the 500-foot contour in 3½ miles, from the 500- to the 480-foot contour in 6½ miles, and from the 480- to the 460-foot contour in 4½ miles.

*Flow.*—The flow of Fox River often increases greatly within a few hours after a heavy rain (pl. 9). Conspicuous variations also occur from year to year. During 1929 the river carried a run-off equivalent to 13.7 inches but in 1934 the total run-off was only 1.87 inches.

The average flow of Fox River at Wedron from 1914 to 1924 was 1,537 second-feet and at Dayton from 1925 to 1935 was 1,414 second-feet (app. F). The lower average at Dayton, where a higher flow would be expected because of its downstream location and consequent larger drainage area, results from the unusually low run-off accompanying the droughts of recent years. The minimum discharge recorded at Wedron was 105 second-feet on November 20, 1914. At Dayton the previous record minimum flow of 151 second-feet was equalled or lowered on 16 days in July, August, and September 1934, when a flow of only 145 second-feet was recorded, and on August 29, 1934, when the water-wheels at the power-house were not operated and the river had no flow. The mean flow for the year October 1933 to September 1934 inclusive was only 330 second-feet, and at no time between July 6, 1933, and November 22, 1934, did the river have a flow as great as its long-time average flow. The maximum flow of the river recorded in 20 years occurred on March 26, 1920, when a peak of 17,900 second-feet was measured.

*Depth and width.*—At low water the river has a maximum width of about 500 feet but is commonly half that width or less. Because of the narrowness of the valley and the absence of a floodplain at many places, the river does not expand greatly when in flood, although some of the low terraces are inundated at extremely high stages which result at times from ice-jams in the lower part of the valley. Except in the area where the water-level is controlled by the Dayton dam, the river has at some places a low-water depth of only a few inches.

*Erosion.*—The river is abrading its channel throughout the entire length except where affected by dams near its mouth and above Dayton. Down-cutting is evidently proceeding slowly, as the base of the present channel has been eroded only from 15 to 20 feet below the level of terraces formed in glacial times. Although the valley-walls are kept steep by lateral erosion of the river, the valley has been widened very little since glacial time, as the river has a very narrow floodplain and at some places occupies almost the entire area of the valley-floor.

### Vermilion River

Vermilion River follows a winding course diagonally across the Streator quadrangle from the southeast corner to the northwest corner. The river continues to flow northwesterly to join Illinois River about six miles beyond the quadrangle. At the gaging station at Lowell, about three-fourths of a mile downstream from the northwest corner of the quadrangle, the river carries the drainage from an area of 1,230 square miles. The headwaters of the river are about 40 miles southeast of the quadrangle, near the southeast corner of Livingston County. Most of the drainage from the Streator quadrangle is carried by Vermilion River, but about 20 square miles along the north side of the quadrangle drains northward to Illinois Valley, and an area of about two square miles along the west margin of the quadrangle, two miles southwest of Garfield, drains westward to Sandy Creek and thence to Illinois Valley. Vermilion River has a much more winding course than either Illinois or Fox Rivers and it flows 30 miles to traverse the 21 miles between the points where it enters and leaves the Streator quadrangle.

*Gradient.*—Vermilion River enters the quadrangle at an elevation of about 580 feet and leaves it at an elevation of 520 feet, a descent of 60 feet in 30 miles, an average gradient of two feet per mile. The regularity with which the 10-foot contours on the topographic map cross the valley about five miles apart indicates the general uniformity of the gradient. However, the descent of the river is marked by many short rapids separated by intervals of gently flowing water. The gradient is decreased slightly in the lower five miles of the river's course in the quadrangle, which is just above the rapids at Lowell, because the beds of limestone that form the rapids have resisted erosion and thereby have increased it in the softer strata above. At the mouths of several tributary streams alluvial fans partially block the river, forming rapids on the downstream slope of the fans and lake-like expansions of the river on the upstream slope. The natural gradient of the river has been altered in the upper part of its course by a dam about two miles above Streator.

*Flow.*—The flow of Vermilion River is similar to that of Fox River in its great variability (pl. 10). The river rises rapidly after a heavy rain and the discharge increases as much as 10-fold in a single day. Large variations also occur from year to year, as the total run-off was 24.34 inches in 1927 but only 1.75 inches in 1934.

At Streator the average discharge of Vermilion River for 16 years was 660 second-feet, and at Lowell for 4½ years was 741 second-feet (app. F). The minimum flow usually occurs in July, August, or September, and at times the water is so low that at some places it can be crossed on stepping-stones. On several days in August and September, 1920, and again in the same months in 1923, no flow was recorded at Streator. The lowest flow at Lowell between 1931 and 1935 was 5.9 second-feet recorded during the drought in August, 1934. A flood stage may follow a heavy rain at any time during the year but is more likely in March, April, or May, when the mean discharge is uniformly high. The maximum discharge recorded at Lowell was 22,200 second-feet

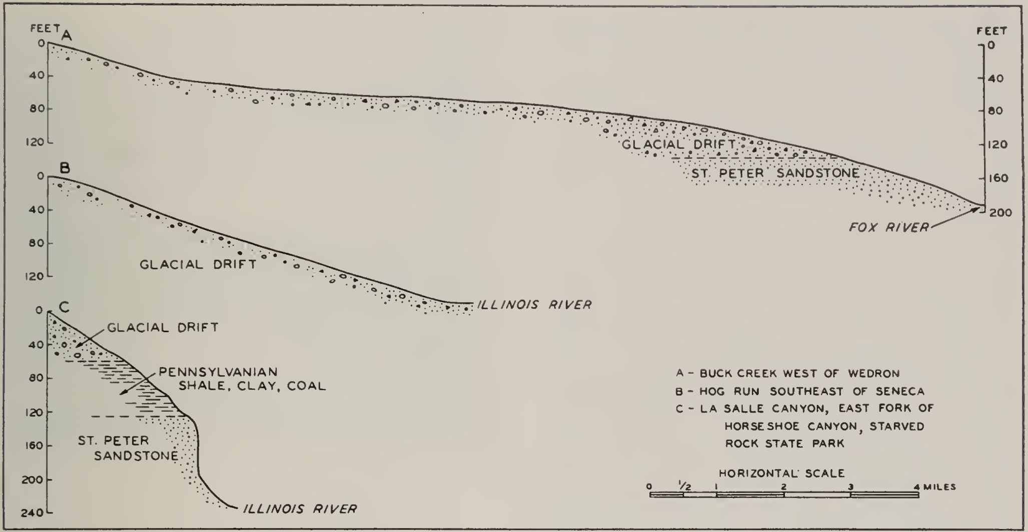



FIG. 8.—Profiles showing variations in types of stream gradients and their relation to bedrock.

on May 12, 1933. A daily mean of 16,500 second-feet was recorded at Streator on April 20, 1920.

*Depth and width.*—The Vermilion River at Lowell has a stage of three feet at average discharge. Although the minimum discharge has a stage of only one foot, the river is reported to have reached a stage of 16 feet during an ice-jam. The river is usually 150 to 300 feet wide except during floods, when it expands and covers the bottomlands which are generally less than a fourth of a mile but are locally half a mile wide. At many places the normal river covers almost the entire valley-floor. The Streator dam has changed the natural depth and width of the river for several miles above Streator.

*Erosion.*—The channel of the river has a very thin deposit of gravel and sand and the river probably scours its channel to bedrock at nearly every period of high water and increased velocity. At these times the river also erodes laterally at the base of its bluffs and by undercutting them maintains steep walls.

*Material transported.*—When in flood the river transports a large quantity of material, as shown by the shifting of bars, the erosion of large quantities of loose rock materials along its banks, and the muddy waters. At low water the water is nearly clear and transports very little material. The ability of the river to move large rocks is well shown in the rapids at Lowell where many blocks of limestone 2 to 4 feet in size have been detached from the parent ledges and moved as much as 100 yards below the lowest outcrop of the limestone. Farther down the valley the blocks are numerous but rapidly decrease in size and increase in degree of rounding with distance. Many rounded cobbles 6 inches in diameter occur a quarter of a mile downstream.

## STREAMS

A network of streams tributary to the three rivers penetrates all parts of the area (fig. 5). The streams are of all sizes from small rivulets to large streams, such as Indian Creek, whose headwaters are 25 miles north of the Ottawa quadrangle. In general the courses of the tributary streams are more winding than the rivers, as they are more affected by minor irregularities of the glacial topography. For example, the headwaters of Covel Creek, near Diehl School in the Ottawa quadrangle, are only five miles from the mouth of the stream but the valley is approximately 15 miles long exclusive of all the devious turns in the channel of the creek.

*Gradients.*—The gradients of the tributary streams reflect variations in the topography on which they developed as well as differences in the character of the materials in which they are incised. Many of the streams in this area head in the glacial moraines, flow across the flat surfaces of the upland lake plains, and cut sharply through the glacial deposits and bedrock to join the major rivers. As a result they usually have gradients of 20 to 40 feet per mile in the headwaters, 5 to 15 feet per mile across the lake flats, and usually about 20 feet but not uncommonly 40 feet per mile in the lower parts of their courses, as is well shown by the profile of Buck Creek (fig. 8A). The gradients of shorter streams in valleys excavated entirely in glacial drift, as near Seneca, decrease fairly uniformly from source to mouth (fig. 8B) except where landslides have partially blocked the valleys, but where the streams cut through the drift into bedrock near their mouths they have a much steeper gradient than in the upper parts of their courses where they flow in drift. In extreme cases, as in Starved Rock Park, where the bedrock consists of uniformly hard rock, like sandstone, the streams drop over high falls in their lower courses (figs. 8C, 9), but if the bedrock consists of the variable strata of Pennsylvanian age, there are numerous small falls or rapids wherever the more resistant strata crop out (fig. 10).

Fig. 10.—Valley eroded in Pennsylvanian strata, showing waterfall produced by a hard stratum overlying soft shale along Little Horseshoe Canyon, NE. ¼ NW. ¼ SW. ¼ sec. 30, T. 33 N., R. 3 E. (South Ottawa Twp.), Ottawa quadrangle.

Fig. 9.—French Canyon in Starved Rock State Park, showing falls at the head of the box-like valley eroded in St. Peter sandstone. The corrugations are due to hard and soft parts of the sandstone layers.

*Flow.*—The flow of the streams is roughly proportional to the size of their drainage areas although variations result from differences in the permeability of the underlying materials. The streams rise quickly after rainfall in their drainage areas and because of their steep gradients they have rapid currents and soon carry the run-off into the major valleys. Many of the streams dry up completely during intervals of drought when the water-table sinks below the bottoms of the valleys, and the permanency of the streams is subject to the vagaries of local rainfall, the presence of springs, and the permeability of the bedrock.

*Erosion.*—Practically all the streams in the area are degrading their channels, although a few which flow into artificial lakes are locally aggrading parts of their valleys. Erosion is extremely slow along many of the streams flowing through the upland flats.

*Material transported.*—Most of the material transported by the streams is moved during intervals of high water. The streams in flood are capable of moving very large rocks, which is especially evident along the streams that are cutting in strata of Pennsylvanian age. Large fragments of identifiable strata are found long distances down the valleys from the outcrops. Slabby rocks, such as black shales or "slates," are easily transported. They may be traced down the valleys, and the effect of abrasion during transportation is shown by the progressively smaller size of the fragments farther from the outcrops.

### LAKES AND SWAMPS

Artificial lakes occur along all the major valleys but natural lakes are rare. None occur in the upland areas, although there are a number of small swampy depressions that were probably once occupied by lakes. When the topographic maps were made, several small lakes or ponds were shown on the Marseilles moraine in the Marseilles quadrangle and on the Farm Ridge and Cropsey moraines in the Streator quadrangle. All have since been drained, although after heavy rains these as well as many other depressions are the sites of temporary lakes.

McNellis Bayou, in the Marseilles quadrangle, about four miles east of Seneca, is a floodplain lake and marks the position of an abandoned channel of Illinois River. Many swampy tracts occur along channels or in depressions on the terraces in Illinois Valley. They were produced by irregular erosion of the terraces by glacial flood-waters and are supplied with water from springs and from small streams which carry drainage from the adjacent upland areas.

### SPRINGS

Springs occur along the valleys and are especially common at the contact of glacial drift and bedrock or at the outcrops of beds of sand and gravel in the drift. The larger and better known springs are the Sulphur Springs at Sulphur Springs health resort, the Brookfield Spring two miles southeast of Marseilles, and the Salt Spring in Starved Rock State Park at the mouth of Kaskaskia Canyon. The Sulphur Springs has the odor of hydrogen sulfide gas and the Salt Spring has a distinctly salty taste, although analyses indicate the salt content is low in comparison with some other natural brines.

## TOPOGRAPHIC FEATURES

The major features of the topography consist of the broad uplands and the steep-walled valleys. More than 90 per cent of the area is prairie upland, marked by extensive flat plains and broad gentle-sloped ridges. The ridges are moraines, except for one large esker, and the plains are areas of ground-moraine and lake plains (fig. 11). As these features are largely glacial in origin and correspond to units in the classification of the glacial deposits, the names applied to them in the chapter on stratigraphy (pp. 142-180) are also used here.

### UPLANDS

#### Ridges

The ridges all have a swell-and-swale topography typical of glacial moraines. Flat surfaces are rare. The ridges are seldom straight for any great distance but usually curve in broad lobes, and the contacts between them and the adjoining plains are usually marked by many smaller lobate extensions of the ridge and broad reentrants in its frontal slope. They usually have an asymmetric profile, steeper on the west or front than on the east or back slopes. The contact with the frontal plain is commonly distinct but on the back slope the change to ground-moraine is gradational. The crests of the ridges are distinctly undulatory and at some places are broken by deep rounded gaps or channels. The surfaces of the ridges are marked by many rounded hills or knobs without any uniformity in size, shape, or steepness. None of the slopes are too steep for cultivation. Between the hills are depressions or kettles which have no natural outlets and are usually swampy unless artificially drained. Many of the depressions are very shallow and their abundance is seldom realized until a heavy rain forms temporary lakes in them.

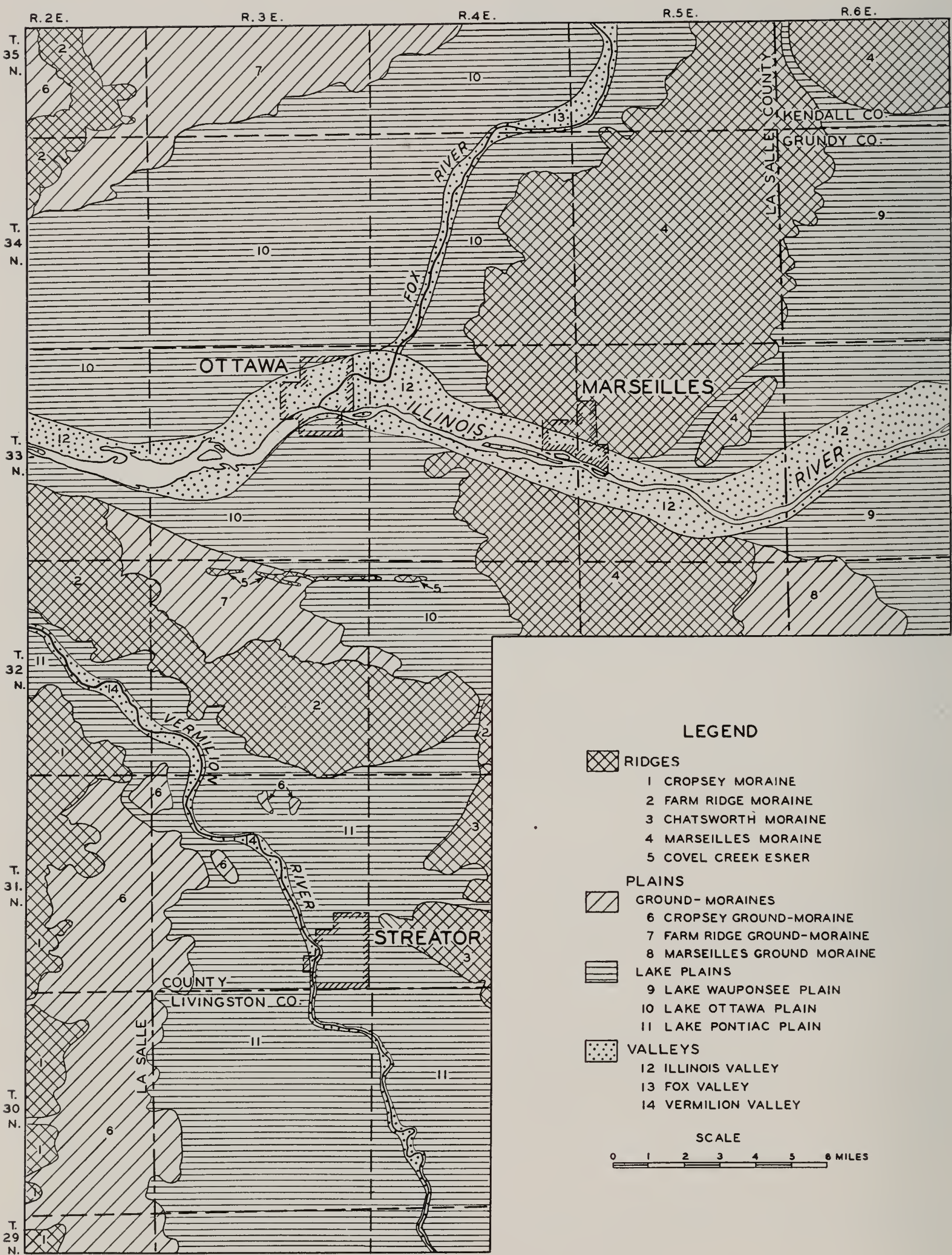



Fig. 11.—Distribution of the topographic features in the Marseilles, Ottawa, and Streator quadrangles.

The character of the topography is revealed by the mottled pattern of the soils as shown on aerial photographs (fig. 12). The light-colored areas are the upper parts of the hills where the soils are more subject to erosion and to oxidation and consequently contain less humus than those in the lower areas. Locally on some of the hills light-colored soils surround dark centers (fig. 13). The tops of these hills are relatively flat and have not been affected by erosion and oxidation as much as the outer slopes.

### CROPSEY MORAINE

The Inner Cropsey morainic ridge lies along the west side of the Streator quadrangle. The crest of the ridge is west of the quadrangle, although west of Leonore it is within half a mile of the quadrangle. The moraine has a maximum width of about five miles at the south and narrows to two miles at the north. The crest of the ridge commonly has an elevation between 700 and 730 feet above sea-level; it is 25 to 50 feet above the level of the Cropsey ground-moraine behind it, about 80 feet above the old lake plain at Streator, but only about 40 feet higher than the area west of the moraine. It has a typical morainic topography although individual hills are rarely more than 20 feet high and the slopes of the hills are not as steep as on some of the other morainic ridges.

### FARM RIDGE MORAINE

The Farm Ridge morainic ridge follows a broad curve through the northwest and southwest corners of the Ottawa quadrangle and the north side of the Streator quadrangle. The ridge varies in width, having a maximum width of three to four miles in the north part of the Streator quadrangle but narrowing sharply in both directions to less than a mile in width. It has a maximum elevation of slightly more than 720 feet but is commonly between 680 and 700 feet. The front slope of the ridge is distinct, rising 40 to 50 feet above the frontal plain in about half a mile. The back slope is more gradual. The ridge has a topography similar to that of the Cropsey ridge, but the relief is sharper, especially at the west end of the moraine in the Streator quadrangle where one prominent hill is 50 feet high and several other sharp knobs are present. In the northwest part of the Ottawa quadrangle several broad, deep channels extend entirely through the moraine.

### CHATSWORTH MORAINE

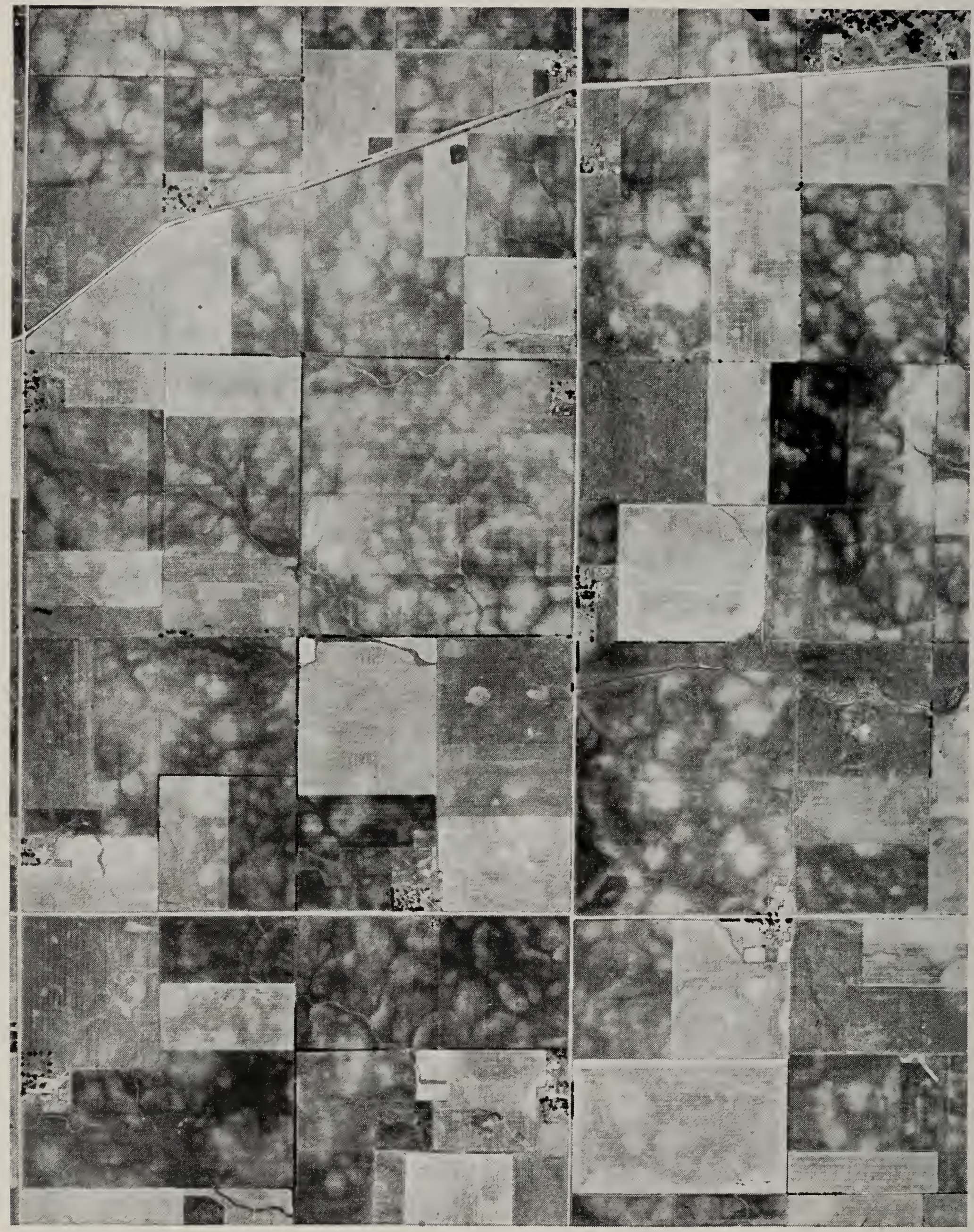
The Chatsworth morainic ridge lies along the east side of the Streator quadrangle, into which it extends three miles at the most although its total width is considerably more. The maximum elevation of the moraine in this quadrangle is 670 feet but it is higher to the east. The moraine rises 30 to 40 feet above the lake plain in front of it. Directly east of Streator the moraine has a distinct front with a rise of about 30 feet in a quarter of a mile but it is less distinct farther north. The topography of the ridge is undulatory but the relief is less prominent than that of the other moraines in the area.

### MARSEILLES MORAINE

The Marseilles morainic ridge covers most of the western half of the Marseilles quadrangle and extends a short distance into the Ottawa quadrangle. It is by far the largest of the moraines in the area and one of the largest in the State. It has a width of about 10 miles along Illinois Valley but narrows northward and is only about four miles wide at the north side of the Marseilles quadrangle.

The maximum elevation of the crest of the moraine is between 780 and 800 feet, nearly 100 feet higher than the other moraines in the area. In the Marseilles quadrangle about 40 square miles of the moraine has an elevation above 700 feet, which is about the maximum elevation of the other moraines. The crest of the moraine is about 160 feet above the lake plains on both sides of the moraine.

Because of its height the moraine is visible from the paved highway north of Ottawa about four miles west of the ridge. From this position the moraine appears to rise sharply to its crest, but a closer examination shows that it rises by three steps. The extreme western part of the moraine is a low morainic area that has an indistinct break with the lake plain and was probably covered by the lake. A low frontal apron of this type is locally



*Photograph by Illinois Agricultural Conservation Committee*

Fig. 12.—Aerial photograph of the Marseilles moraine, about eight miles north of Seneca, showing the mottled soil pattern consisting of light-colored spots on the hills, where the soils are relatively low in humus, and dark-colored areas along the streams and drainage courses. The soil pattern is less distinct in the lighter colored fields. The crossroads in the south-central part of the picture is at the SE. cor. sec. 1, T. 34 N., R. 5 E. (Miller Twp.), Marseilles quadrangle. Scale, approximately three inches equals one mile.

*Photograph by Illinois Agricultural Conservation Committee*

Fig. 13.—Aerial photograph of the Marseilles moraine immediately north of Seneca, on which there are numerous flat-topped hills with dark soil on the tops surrounded by light-colored soils on the slopes (upper part of photograph), in contrast to the more uniform soils in Illinois Valley at Seneca (lower part of the photograph). Scale, approximately three inches equals one mile.

Fig. 14.—View across gap in the Marseilles moraine along the S. line of sec. 19, T. 35 N., R. 6 E. (Big Grove Twp.), Marseilles quadrangle.

present along many of the moraines but is much broader along the Marseilles moraine, where it has a maximum width of nearly four miles. A distinct topographic rise at an elevation of about 640 feet in the area of the frontal drift probably marks the highest elevation of the area affected by the lake waters. Above an elevation of 660 to 680 feet the moraine rises sharply to its crest and then lowers gradually to the east.

The topography of the ridge is distinctly rougher than that of the other moraines. A well-developed knob-and-kettle topography exists at several places (fig. 12), especially near the northeast corner of the Marseilles quadrangle. A few small kames and eskers occur on the moraine south of Marseilles. The moraine is crossed by two deep channels, one of which is occupied by Illinois River and the other (fig. 14), near the north end of the Marseilles quadrangle, was an important drainage line during glacial time when it served as the outlet of a large lake although at present it is occupied by a small ditch. The front of the moraine is also marked by many valleys which form long reentrants in the front of the moraine but do not usually extend as far as the crest of the moraine. Brumbach Creek, however, extends for nearly a mile beyond the line of the crest, lowering it about 80 feet. Although these valleys have the general shape of valleys cut by running water, characteristic morainic topography extends down their slopes, which shows they are the result of irregular morainic deposition, not of erosion. They probably mark lines of subglacial drainage.

#### COVEL CREEK ESKER

Covel Creek esker occurs in the Ottawa quadrangle about five miles south of Ottawa. It is a remarkably straight ridge about seven miles long and usually a little less than a quarter of a mile wide. It rises from 10 to 20 feet above the surrounding plain and is approximately symmetrical in shape. The crest of the ridge is undulatory, varying in elevation from 620 feet near Covel Creek to about 660 on the back slope of the Farm Ridge moraine.

### Plains

The upland plains consist of gently undulatory ground-moraines and of flat lake plains.

#### GROUND-MORAINES

The areas of ground-moraine are not sharply differentiated from either the morainic ridges or the lake plains but merge gradually into them. Their topography is similar to that of the morainic ridges in that it is characterized by irregular hills and depressions but differs in that the local relief is much less, being rarely as much as 20 feet and usually less than 10 feet. The hills are broad, the slopes are gentle, and the depressions are shallow. The general level of their surfaces usually slopes gradually away from the moraine.

Cropsey ground-moraine occurs in an area two to four miles wide between the Cropsey moraine and the Lake Pontiac flat in the Streator quadrangle and has a typical ground-moraine topography.

Farm Ridge ground-moraine occurs along the north and south sides of the Ottawa quadrangle and in the north part of the Streator quadrangle. In the area north of Ottawa the topography is characterized by many broad and shallow channels which are rarely present in the other areas of ground-moraine. The channels apparently represent drainage lines near the front of the glacier during the deposition of the ground-moraine.

Typical ground-moraine topography occurs behind the Marseilles moraine south of Illinois Valley in the Marseilles quadrangle.

### LAKE PLAINS

The lake plains were formed by flood waters of the Kankakee Torrent (p. 167), when the principal valleys were not large enough to carry all the waters from the melting ice and the water overflowed onto the uplands. The areas inundated were largely ground-moraine and already had a subdued topography which was further leveled by the activities of the lakes. The lake plains are characterized by their flatness, although they have many broad low swells. Aerial photographs of the lake plains (fig. 15) reveal their flatness by showing them as an almost uniformly colored soil varied only by darker colored soils along the intricately branched drainage lines, in strong contrast to the mottled soil pattern reflecting the irregular topography of the moraines (fig. 12). Broad shallow channels are locally present, especially in the lower parts of the plains. Some of them mark the position of currents in the lakes but others may be relics of channels formed by drainage from the glacier during deposition of the ground-moraine.

#### *Lake Waupονsee Plain*

The Lake Wauponsee plain occurs along the east side of the Marseilles quadrangle and includes all the upland below a level of about 650 feet. The contact between the moraine and the lake plain is not distinct and in places is difficult to locate within a quarter of a mile. The lower part of the plain, especially below 620 feet, is unusually flat.

#### *Lake Ottawa Plain*

The Lake Ottawa plain occupies most of the central part of the Ottawa quadrangle but extends into all the surrounding quadrangles. The plain includes all the area below an elevation of about 640 feet, and the lowest parts have an elevation of about 600 feet. The plain has a distinct contact with the Farm Ridge moraine, especially in the area a short distance outside of the Ottawa quadrangle. At some places along the front of the Marseilles moraine a distinct topographic change occurs at an elevation of 640 feet but is not recognizable at others. Most of the plain has an extremely flat surface with a distinctive drainage pattern (fig. 5) that was probably produced by channeling of the surface by currents in the lake.

#### *Lake Pontiac Plain*

The Lake Pontiac plain covers most of the central and southeast part of the Streator quadrangle and extends up Vermilion Valley to a few miles east of Pontiac. The plain covers all the upland area below an elevation of 650 feet. The lowest part of the plain is at an elevation of about 610 feet a short distance southeast of Streator. The plain is a large lenticular basin outlined by the 650-foot contour on the Streator and Pontiac quadrangle maps. At its broadest part near the southeast corner of the Streator quadrangle the basin is at least 12 miles wide but in both directions from there it narrows to a width of about 1½ miles a short distance above Pontiac and below Streator near Kangley. East of Streator the plain has a sharp contact with the Chatsworth moraine, the front of which may have been steepened by wave action. The contact is somewhat less distinct along the Farm Ridge moraine north of Streator and is generally indistinct west of Streator where the plain is bordered by Cropsey ground-moraine. The lowest part of the plain near Vermilion River is marked by shallow channels probably cut as the lake receded (fig. 107).

### VALLEYS

Variations in the shapes of valleys result from differences in the rock in which they are eroded and in fluctuations in the flow of the rivers and streams which eroded them. Some of the valleys in the Marseilles-Ottawa-Streator area are eroded entirely in unconsolidated glacial drift, some partly in drift and partly in bedrock, some mostly in bedrock. The bedrock in some places is of a uniform character, such as all shale or sandstone, but in others it consists of several kinds of rocks of variable resistance to erosion. Some of the larger valleys were eroded by floods of glacial melt-water whereas others have been produced by the normal run-off of the rainfall since glacial times.

*Photograph by Illinois Agricultural Conservation Committee*

Fig. 15.—Aerial photograph showing the characteristic soil pattern of the Lake Pontiac plain immediately southwest of Streator. Dark-colored soils occur along the stream courses and uniformly light-colored soils occur in the intervening flat areas; the pattern is less distinct in the lighter colored fields. The northeast corner of the picture is at the center of sec. 2, T. 30 N., R. 3 E. (Reading Twp.), Streator quadrangle. Scale, approximately three inches equals one mile.

Fig. 16.—Valley eroded in unconsolidated glacial drift, NE. ¼ NE. ¼ sec. 17, T. 33 N., R. 5 E. (Manlius Twp.), Marseilles quadrangle.

## Types of Valleys

*Valleys in Glacial Drift.*—Unconsolidated glacial deposits mantle almost the entire area so that the heads of nearly all valleys are excavated in drift and in a few areas the entire courses of the valleys are in drift. Generally the valleys excavated in drift do not have as steep walls as the other types of valleys, because the drift is more rapidly eroded by slopewash than is bedrock and consequently the slope is reduced both by erosion of the upper parts of the walls and by deposition of the eroded material in the valleys (fig. 16). Although the valley-walls may be locally steep where continuously undercut by the streams, they are practically never vertical, certainly not for a long time, and they are usually smooth slopes because of the uniform resistance of the deposits, although at some places there are step-like benches resulting from repeated land-slips. Valleys in drift have much broader bottom-flats than do valleys of streams of about the same size in bedrock. In the uplands the streams have shallow valleys with more or less indefinite low walls and because of their low gradients they frequently develop a meandering course and relatively broad bottomlands. Good examples of valleys excavated entirely in glacial drift occur south of Seneca.

*Valleys in Pennsylvanian bedrock.*—The bedrock of Pennsylvanian age contains thick layers of sandstone and shale which are soft and easily eroded. The valleys eroded in them are not greatly different from the valleys eroded in glacial drift, although generally they have steeper valley-walls and narrower bottomlands. Locally the sandstones are massive and form vertical walls, but usually this occurs only where the walls are undercut almost continuously by the streams.

In some areas the Pennsylvanian strata contain thin layers of resistant rocks such as limestone, "slate," and firmly cemented sandstone, separated by soft shales, sandstones, and clays. Valleys cut in these beds commonly have irregular walls with projecting ledges of hard layers and the streams flow over a succession of waterfalls or rapids formed by outcrops of the hard layers in the stream beds (fig. 10). Many small streams have narrow box-like canyons formed by erosion of soft materials from below resistant ledges of rock often only a few inches thick. A good example is the small canyon near the SW. corner NW. ¼ NW. ¼ sec. 31, T. 32 N., R. 3 E. (Vermilion Twp.), Streator quadrangle.

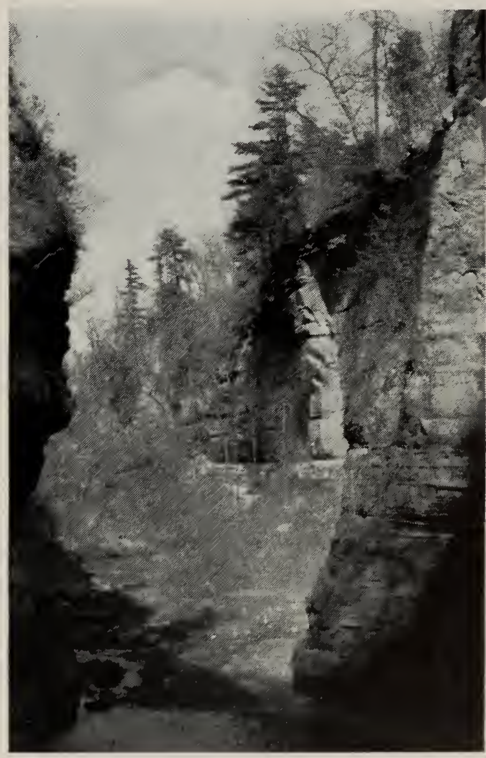


Fig. 17.—View down Tonti Canyon from head of lower canyon in Starved Rock State Park, showing vertical walls of St. Peter sandstone.

FIG. 18.—Vertical and horizontal indentations in St. Peter sandstone eroded along joints and bedding-planes in east bluff of Fox River, north of Wedron, NW. ¼ NW. ¼ sec. 10, T. 34 N., R. 4 E. (Rutland Twp.), Ottawa quadrangle.

*Valleys in St. Peter sandstone.*—Almost all valleys eroded in the St. Peter sandstone have vertical or nearly vertical walls (fig. 17), forming canyons almost as wide at the bottom as at the top. The fresh sandstone is very soft and friable but when exposed it develops a resistant surface by "*case-hardening*" (p. 77). In some places a firmly cemented bed of sandstone at the top contributes to the steepness of the walls. The valley-walls are highly irregular with many deep rounded horizontal indentations along bedding-planes and vertical reentrants along joints (fig. 18. See also figs. 9, 22). At many places the walls have been undercut by the streams, forming caves (fig. 19), and these frequently occur at several levels along the walls. Circular holes, called *potholes*, excavated by whirling currents at the base of falls or rapids, are common along valleys in the St. Peter sandstone. Cross-sections of potholes (fig. 19) occur on the valley-walls above the present streams and mark previous levels of the streams. Unusual topographic forms, such as windows, are locally present in the valley-walls and commonly result from erosion along joints (fig. 20). In the terrace west of Ottawa the surface of the St. Peter sandstone is intricately dissected by sharp channels (fig. 21), but they are filled with loose rock debris and only the larger ones are reflected in the surface topography.

FIG. 19.—Undercutting of the St. Peter sandstone to form caves, and section of an ancient pothole near the mouth of Buck Creek, center SE. ¼ NW. ¼ sec. 9, T. 34 N., R. 4 E. (Dayton Twp.), Ottawa quadrangle.

*Composite types.*—Most of the larger valleys are eroded through both drift and bedrock and consequently are composites of the types described above. For example, the upper part of the valley of Illinois Canyon at the east end of Starved Rock Park is excavated in drift and has gentle smooth slopes; the middle part is excavated in Pennsylvanian deposits and has steep irregular valley-walls, falls over the hard layers, and uniform gradients over the soft shales; and the lower part is a vertical-walled canyon in the St. Peter sandstone.

## ILLINOIS VALLEY

Illinois Valley has steep valley-walls and a broad bottomland unusually uniform in width (fig. 3). It is comprised of several remarkably straight sections separated by sharp bends. For instance, at Ottawa the valley makes a bend of about 60 degrees in about a mile but east of Ottawa it is almost straight for 12 miles.

The unusual uniformity in width and the steepness and straightness of the valley-walls results from the glacial origin of the valley. The broad bottomland is not the result of lateral erosion of a meandering river but was eroded by glacial floods which covered the valley-floor from bluff to bluff.

*Valley-walls.*—The valley-walls have a maximum height of about 160 feet near Starved Rock and at a few places near Marseilles. Elsewhere west of Seneca the valley-walls are 120 to 140 feet high. East of Seneca the south valley-wall gradually decreases to about 80 feet at the margin of the quadrangle and the north valley-wall decreases to about 40 feet at Young School, a mile from the edge of the quadrangle. East of that the valley-wall is only about 20 feet high.

At most places the steepness of the valley-walls is inherited from glacial time, as terraces protect the bluffs from erosion by the present river. About a mile southwest of Seneca the bluff is more gentle than elsewhere and appears to have been protected from erosion even by the last glacial floods, by a terrace slightly higher than others along the valley. As the major bluffs are largely the result of erosion by glacial rivers, the walls of the real valley of the present river, which are marginal to its floodplain, are the 20- to 30-foot slopes that terminate the riverside edges of the terraces.

Fig. 21.—Channeled surface of the St. Peter sandstone eroded by Chicago Outlet River, exposed at pit of Libby-Owens-Ford Glass Company southwest of Ottawa, NW. ¼ NW. ¼ SW. ¼ sec. 15, T. 33 N., R. 3 E. (Ottawa Twp.), Ottawa quadrangle.

Fig. 20.—Window formed by erosion along joint in St. Peter sandstone on north side of Buffalo Rock, SE. ¼ NW. ¼ SW. ¼ sec. 17, T. 33 N., R. 3 E. (Ottawa Twp.), Ottawa quadrangle.

East of Marseilles the valley-walls are composed largely of drift although bedrock is exposed locally along their base. Their slopes are more gentle than elsewhere and at many places slope-wash at their base has made gradual slopes to the valley-floor.

From Marseilles west to the mouth of Covel Creek the lower one-half to three-fourths of the bluffs is composed of bedrock of Pennsylvanian age. Although steep, the bluffs are not precipitous except in the vicinity of Marseilles where a massive sandstone is present.

West of Covel Creek, the valley-walls are composed almost entirely of bedrock, the glacial drift having been eroded from the upland near the bluffs. In the first 1½ miles west of Covel Creek the south bluff is largely of Pennsylvanian strata and has steep slopes but farther west it is an almost vertical cliff of St. Peter sandstone 50 to 125 feet high. The north bluff is nearly as precipitous, especially the south side of Buffalo Rock, which is an almost vertical cliff 100 feet high.

From the west edge of the Ottawa quadrangle east to Little Horseshoe Canyon, the south wall of Illinois Valley and also the walls of the canyons which dissect it are characterized by a vertical cliff of St. Peter sandstone uniformly about 50 feet high, from 500 to 550 feet above sea-level. It maintains this uniform height and position except at Starved Rock, Lovers Leap, and the mouth of Hennepin Canyon, at which places the gently sloping terrace that elsewhere extends from the present valley-flat up to the base of the cliff has been eroded by Illinois River and the vertical cliff consequently extends downward. The cliff does not extend above the 550-foot elevation despite the fact that the top of the sandstone rises from an elevation of 550 feet at the east to 580 feet at the west. At the east end of Buffalo Rock there is a similar vertical cliff of sandstone whose base is marked not only by the top of a sloping bench but also by a distinct horizontal groove in the sandstone (fig. 22). This groove, the general base of the cliffs in Starved Rock Park, and the top of a terrace at Ottawa, all have about the same elevation and appear to mark a level of erosion by the flood-waters from glacial Lake Chicago.

Fig. 22.—Groove near the base of Buffalo Rock, SE. ¼ NW. ¼ SW. ¼ sec. 17, T. 33 N., R. 3 E. (Ottawa Twp.), Ottawa quadrangle, eroded by Chicago Outlet River.

Fig. 23.—Starved Rock as viewed from Lovers Leap, showing its isolation from the upland, due initially to the high waters of the Kankakee Torrent.

Rock hills, such as Buffalo Rock and Starved Rock (fig. 23), have been isolated by erosional deepening of channels originally developed by glacial flood-waters flowing over the tops of the hills. Development of the channels may have been facilitated by the presence of joints. A flow of water persisted along the channel north of Buffalo Rock until it was eroded to the lowest glacial terrace, which is only a few feet above the present flood-plain. The situation is similar at Starved Rock, although the channel between Starved Rock and the valley-wall was probably abandoned at an early stage in the glacial floods and was further lowered to its present position by local stream erosion.

*Bottomlands.*—The floor of the valley is remarkably uniform in width, averaging about 1½ miles wide. In general it is broadest at the upstream end where the walls are composed of Pennsylvanian strata and glacial drift, and narrowest at the lower end where it is eroded in St. Peter sandstone. The maximum width of the valley is two miles at the east end of Buffalo Rock, but the bottomlands are 1¾ miles wide at the mouth of Fox Valley and at the east line of the Marseilles quadrangle. The valley is narrowest, 1$\frac{3}{16}$ miles, at Starved Rock. At Buffalo Rock the main part of the valley is only one mile wide but the channel north of Buffalo Rock is a quarter of a mile wide. Variations in the width of the valley result

FIG. 24.—Terraces along Fox River at Dayton, showing the Sulphur Springs terrace about 15 feet above the river and the Serena terrace near the top of the valley-wall. The Sulphur Springs terrace is eroded on the top of the St. Peter sandstone, the Serena terrace in Pennsylvanian shale. View east from bridge, NE. ¼ SW. ¼ SE. ¼ sec. 29, T. 34 N., R. 4 E. (Dayton Twp.), Ottawa quadrangle.

FIG. 25.—Terraces along Fox Valley at Wedron, NW. ¼ NE. ¼ NE. ¼ sec. 9, T. 34 N., R. 4 E. (Dayton Twp.), Ottawa quadrangle. The top of the hill in the background is a remnant of the Serena terrace, the barn at the left is on the Wedron terrace, the next lower level is the Sulphur Springs terrace, and the surface in the foreground is the Indian Creek terrace.

from differences in the resistance of the rocks to erosion and from greater erosion on the outside of the bends in the valley.

The bottomlands consist largely of a glacial erosional terrace in which the present Illinois River occupies a narrow channel. The surface of the terrace is 10 to 20 feet above the floodplain of the river. The floodplain was 5 to 10 feet above low-water level of the river before the dams were built at Starved Rock and Marseilles but now is mostly inundated by the lakes above the dams. Although much of the terrace appears to be flat when seen in the field, aerial photographs show that its surface is a network of imbricating channels and it has a topography distinctly different from that of adjacent areas (fig. 108). At many places the terrace is crossed by channels a quarter of a mile to half a mile wide and 5 to 15 feet deep. At times of unusually high water Illinois River floods these channels. Drainage from tributary valleys also follows the channels to the river and as a result some of them are covered with recent alluvium similar to that in the floodplain of the present Illinois River. Usually bedrock is only a few inches below the surface but a thin cover of gravel is locally present. Shallow depressions on the terrace are often swampy, as southwest of Seneca. The slope of the terrace is essentially the same as the gradient of the river (p. 25) but more uniform. For instance, the river drops steeply at the Marseilles rapids, but the surface of the terrace maintains its gradual slope.

The channel of the present river and its floodplain is about one mile wide at its widest part near Starved Rock and is only slightly more than an eighth of a mile wide at its narrowest. Where the channel is narrow the river has no floodplain and occupies the entire channel.

Alluvial fans are common on the terraces at the mouths of many tributary valleys. They usually have gentle slopes and grade into the slope-wash along the base of the bluffs. One of the larger alluvial fans occurs at the mouth of a small ravine three miles southwest of Seneca.

## Fox Valley

Fox Valley has an almost straight course across the Ottawa quadrangle but makes a large bend through the northwest part of the Marseilles quadrangle. The valley-walls are as high and steep as those of Illinois Valley, and because of the narrow bottomland, the valley is an imposing canyon near its mouth.

*Valley-walls.*—The walls of Fox Valley vary from 80 to 130 feet high but are more commonly between 100 and 120 feet high. The maximum height of 130 feet occurs on the east side of the valley one mile south of Dayton. The slope of the

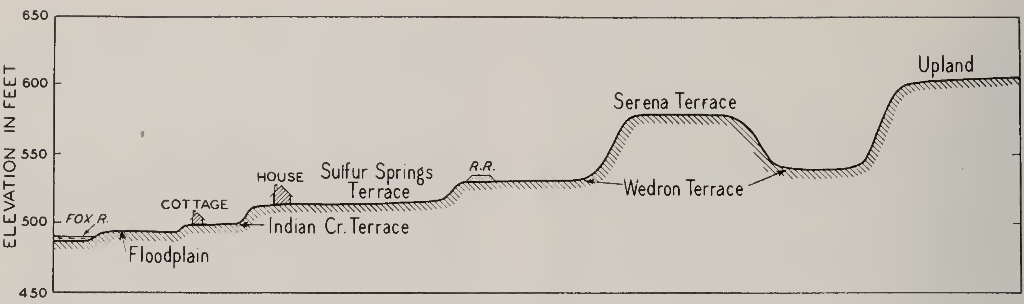



Fig. 26.—Diagrammatic cross-section of terraces on west side of Fox Valley approximately along a line extending southwest from the mouth of Indian Creek, north of Wedron, to the upland.

walls varies. Gentle slopes occur at Sulphur Springs and one mile northeast of Wedron where the walls are protected by terraces. Steep slopes occur near Wedron where the valley is partly eroded in St. Peter sandstone. Vertical bluffs of the sandstone about 50 feet high extend for about half a mile along the east side of the valley at the mouth of Indian Creek and have all the characteristics of the sandstone bluffs in Starved Rock State Park.

*Bottomlands.* — The bottomlands are generally broader in the upper than in the lower part of the valley but are greatly variable in width. They are narrowest, only three-sixteenths of a mile, near Dayton and are widest, nearly three-fourths of a mile, southeast of Serena. The topography of the bottomlands is very irregular because of many isolated remnants of terraces and irregular patches of floodplain. At Dayton and at Wedron the river occupies a rock channel between narrow terraces and has no floodplain. At other places the river has a floodplain nearly a fourth of a mile wide. The presence of several terraces, both erosional and depositional, is well shown at Dayton where there are two terraces, both eroded on bedrock (fig. 24), and at Wedron where there are four terraces, of which the two lower appear to be depositional (figs. 25, 26).

### Valleys Tributary to Fox Valley

Indian Creek is the largest of the numerous valleys tributary to Fox Valley. The valley of Indian Creek has steep walls about 100 feet high near its mouth and 60 feet high at the north boundary of the Ottawa quadrangle. The walls are composed largely of glacial drift, except in the lower mile of the valley where 20 to 30 feet of St. Peter sandstone forms vertical bluffs at their base. High cutbanks of drift occur at places where streams undercut them. The steepness of these banks changes frequently as they are alternately reduced by landslides and then steepened again as the landslide material is washed away by the river. The floor of the valley is one-fourth to three-eighths of a mile wide, wider than much of Fox Valley. Most of the valley-floor is a low terrace 5-15 feet above the creek. Part of it is occasionally flooded. Small remnants of terraces about 20 feet higher are present locally.

Crooked Leg and Buck Creek valleys both have broad shallow valleys with low gradients and meandering streams across the Lake Ottawa plain, and narrow deep steep-walled valleys at their mouths where they are entrenched in St. Peter sandstone. One mile west of Wedron, Buck Creek has a valley-flat one-fourth mile wide but only a third that wide at its mouth. Remnants of low terraces occur along both valleys.

The Fox River tributary valleys in the Marseilles quadrangle are nearly all typical of valleys eroded mainly in drift, as their flats are comparatively broad and their walls moderately steep. The lower courses of some streams are entrenched in 5 to 20 feet of St. Peter sandstone with resultant narrowing of the valleys. The valleys tributary to the lower four miles of Fox Valley in the Ottawa quadrangle are typical of valleys eroded in Pennsylvanian bedrock. They have steep valley-walls and narrow valley-floors with waterfalls over the resistant beds.

FIG. 27.—View showing three terraces along tributary to Fox Valley, one mile south of Sulphur Springs, near center sec. 21, T. 34 N., R. 4 E. (Rutland Twp.), Ottawa quadrangle. The uppermost terrace shows only at the left side just below the upland.

Several terraces are present along many of the tributary valleys (fig. 27). As the terraces are gradually dissected by stream erosion, isolated knobs are sometimes formed by shifting of the channels or by stream piracy. A good illustration of this process occurs at the mouth of the tributary valley 1¼ miles south of Sulphur Springs, near the center of sec. 21, T. 34 N., R. 4 E. (Rutland Twp.), where three such knobs occur (fig. 28). At an early stage in the development of this valley the stream eroded a wide channel at a level approximately that of the tops of the knobs, of large remnants of terrace a short distance up the valley, and of the extensive Wedron terrace in Fox Valley. When Fox Valley was eroded down to the level of the Sulphur Springs terrace the tributary stream entrenched itself in its valley-flat at the position shown by the dashed line (fig. 28). A curve of the stream was thus directed against and eventually cut through the narrow wall which separated it from the Fox Valley at A, thus isolating knob No. 1. In a similar manner curves of the stream above and below B cut through and isolated knob No. 3. The abandoned channels (S) between knobs Nos. 1 and 3 and the main valley-walls are approximately at the level of the Sulphur Springs terrace. During the Sulphur Springs stage the small tributary stream X which had previously followed the position shown by the dashed line was probably diverted to the north by piracy and knob No. 2 was isolated. At present the stream is cutting the ridge at C and may eventually isolate another knob north of A.

## VERMILION VALLEY

Vermilion Valley, with its steep walls and narrow bottomlands, is a sharp canyon surrounded by flat prairies. It winds diagonally across the Streator quadrangle and is rarely straight for as much as a mile.

*Valley-walls.*—The walls of the valley are highest, 75 to 110 feet, in the northwest part of the Streator quadrangle. They decrease in height up the valley to 60 to 80 feet at Streator and are only about 40 feet high at the south boundary of the quadrangle, not only because the level of the river rises but also because the upland surface lowers in that direction. The valley-walls are steepest where they are partially excavated in massive sandstone, for example, about four miles east of Leonore, in the middle part of sec. 32, T. 32 N., R. 3 E. (Farm Ridge Twp.), and two miles southeast of Streator, in secs. 7 and 18, T. 30 N., R. 4 E. (Newtown Twp.). They have gentle slopes at places protected from erosion by terraces, espe-

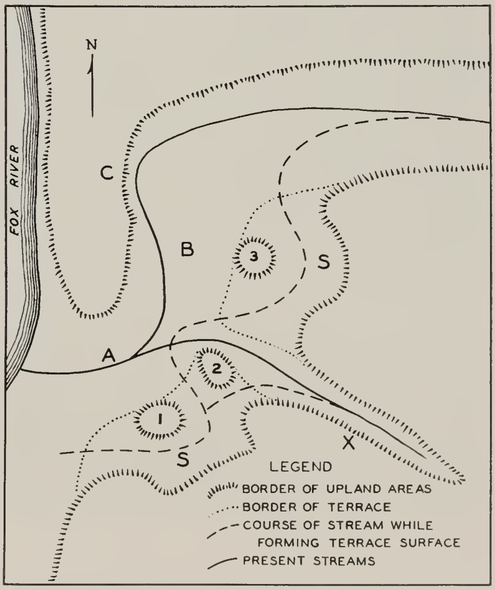
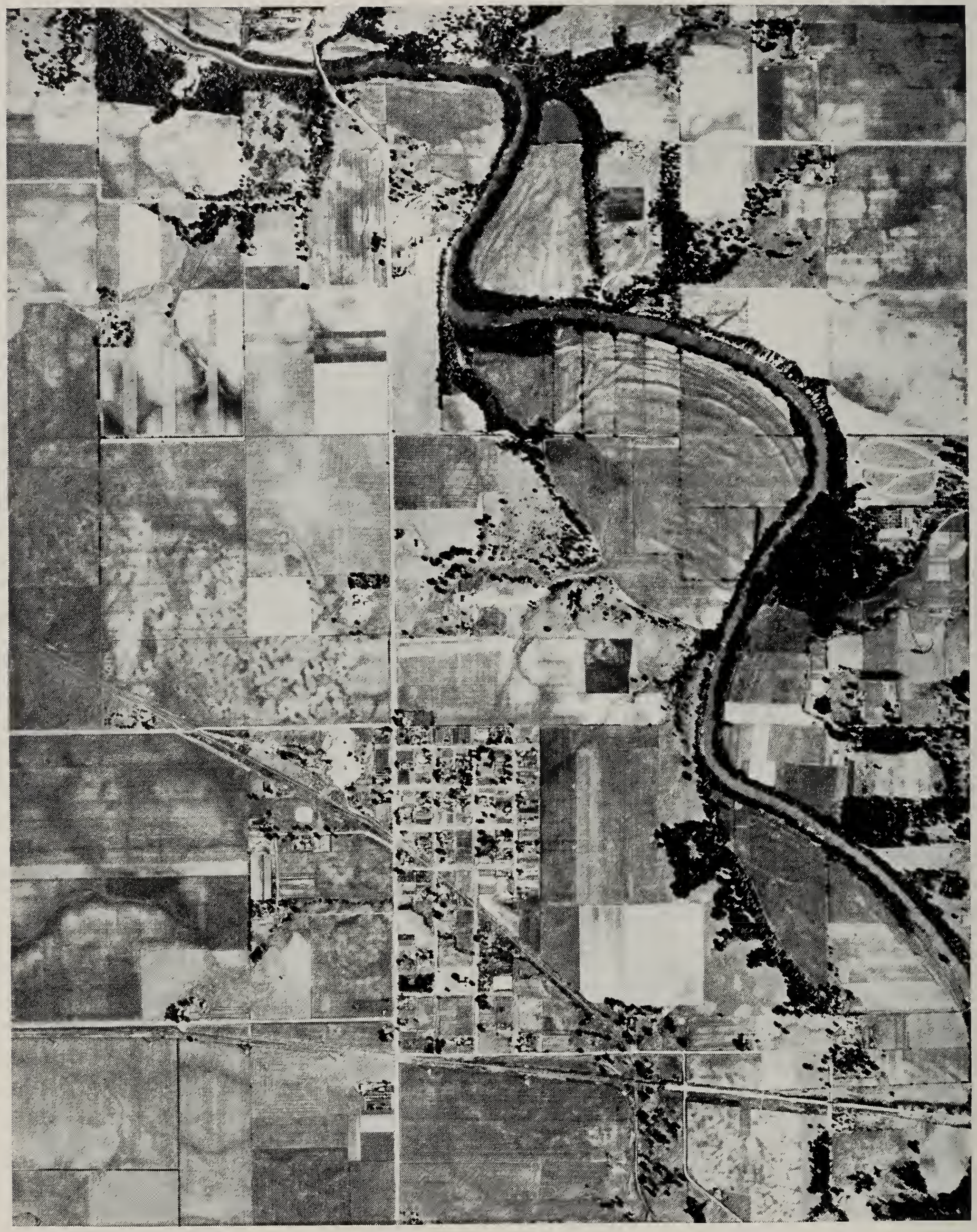



FIG. 28.—Sketch showing probable manner in which knobs were formed at mouth of valley one mile south of Sulphur Springs, near center sec. 21, T. 34 N., R. 4 E. (Rutland Twp.), Ottawa quadrangle.



*Photograph by Illinois Agricultural Conservation Committee*

Fig. 29.—Aerial photograph of area in the vicinity of Kangley, showing (1) ridged character of floodplain along Vermilion River northeast of the town and (2) sinkhole topography (speckled soil-pattern) resulting from subsidence over mined-out area immediately northwest of the town. The dark spots in the latter area are the sinks. Scale, about 3 inches per mile.

cially along the inside of the bends where the river is directed against the bluffs on the outside of the bends. This is well shown at the big bends northwest of Streator.

*Bottomlands.*—The bottomlands vary in width from about 200 to 2,000 feet. The valley is only about 200 feet wide south of Streator at the bridge of the Atchison, Topeka and Sante Fe Railroad. At such narrow places the river occupies almost the entire bottom of the valley. The bottomlands are widest northeast of Kangley. The widest areas are usually at bends in the valley and result from lateral erosion of the river. Narrow remnants of terraces are present at many places and at least four terraces occur at some localities. The floodplain is characterized by roughly parallel ridges which mark successive positions of the river channel as it has widened the valley. The ridges are too low to be shown on the topographic map but because of differences in the color of the soils on the ridges and in the intervening depressions they show distinctly on aerial photographs (fig. 29).

### Valleys Tributary to Vermilion Valley

The valleys of the streams tributary to Vermilion River nearly all have similar gradients—low in the upper parts of their courses where they cross the flat uplands and are entrenched in glacial drift, and steeper in their lower courses where they are entrenched in bedrock. For instance the tributary valley at Wilsman, about five miles northwest of Streator, has a gradient as low as 10 feet per mile above Wilsman but below the village it increases rapidly to about 80 feet per mile in the lower one-fourth mile of the valley.

Above Streator the valleys are eroded mostly in drift and in Pennsylvanian shale and sandstone of fairly uniform resistance to erosion. Below Streator, however, the Pennsylvanian strata contain beds of variable resistance, and small waterfalls and box-like canyons occur along many of the streams. The valleys in the west part of sec. 31, T. 32 N., R. 3 E. (Vermilion Twp.), and in the SE. ¼ sec. 15, T. 32 N., R. 2 E. (Deer Park Twp.), Streator quadrangle, are typical.

### Other Valleys Tributary to Illinois Valley

Covel Creek, in the south part of the Ottawa quadrangle, is one of the larger tributaries of Illinois Valley in this area. It has a valley typical of those headed in glacial drift and excavated in the lower part in Pennsylvanian strata of variable hardness. Some of the tributary branches of Covel Creek heading in the Marseilles moraine were probably formed by drainage from the Marseilles glacier, but most of the valley was developed after Marseilles time and glacial waters played a very small part in its erosion. However, its course was determined by the glacial topography. By widening its channel at various stages in the downcutting of Illinois Valley, the stream formed erosional terraces at three levels. The stream is entrenched in a narrow channel in the terraces. Where the stream cuts against the banks, high cliffs have been formed. Almost vertical cliffs about 80 feet high occur at three places along the north side of the valley in NE. ¼ sec. 27 and N. ½ sec. 28, T. 33 N., R. 3 E. (South Ottawa Twp.), Ottawa quadrangle, where a bed of massive sandstone occurs at the top of the bluffs. The narrowest part of the valley is at its mouth where the stream flows through a narrow canyon 140 feet deep and only 100 feet wide at its base. The narrowness of the canyon results from the presence of about 20 feet of resistant sandstone at the top of the bluffs and 15 to 20 feet of limestone at its base. The sandstone is absent for some distance up the valley. Consequently the valley remained narrow at the mouth where protected by the sandstone, although it was widened upstream in the less resistant rocks. When the valley was eroded about 120 feet deep, it cut a narrow channel in the resistant limestone and was thus prevented from widening the valley by lateral planation.

West of Covel Creek the lower parts of the valleys are excavated in St. Peter sandstone, and the upper parts are in glacial drift and Pennsylvanian strata. The valleys are broad and have gently sloped walls where eroded in drift, but they become noticeably narrower and steeper where eroded in Pennsylvanian strata, and in the St. Peter sandstone

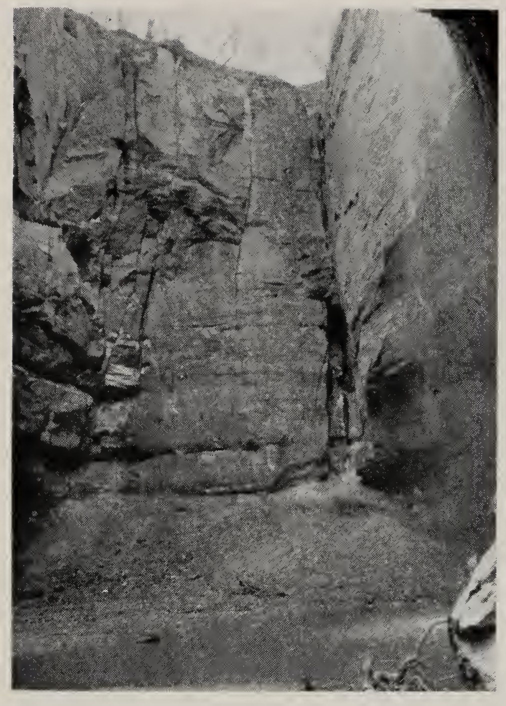


FIG. 30.—Head of Tonti Canyon in Starved Rock State Park, showing the vertical joints along which erosion has developed the valley.

they are canyons with vertical or overhanging walls (fig. 17).

Most of the canyons are in Starved Rock State Park.[5] The canyons are about 50 feet deep and some are little if any wider. Most of them are less than half a mile long. At their head they end in an amphitheater-like enclosure surrounded in all but the outlet direction by sheer walls of sandstone (fig. 9). The streams drop from the upper parts of the valleys to the floor of the amphitheaters by a single falls or by a series of falls and steep rapids. The position of some of the canyons is controlled by joints in the sandstone. For instance Tonti Canyon has been widened along two parallel vertical joints which control both the direction and width of the canyon and give it a rectangular shape (fig. 30). The sandstone is badly fractured along the joints making a zone from 2 to 4 feet wide that is easily eroded in comparison to the non-fractured rock.

Many of the valleys tributary to Illinois Valley in the Marseilles quadrangle have tortuous courses resulting from the rough topography of the Marseilles moraine on which they developed. Those near Marseilles rise in the high parts of the moraine and have deep narrow channels with a high gradient. Approximately the upper half of the valleys is eroded in drift and the lower half in Pennsylvanian sandstone. Each of the valleys has a large number of short branches which are sharply cut ravines. Near Seneca the tributary valleys are eroded mostly in glacial drift and have more gentle gradients, fewer branches, more gently sloping walls, and broader bottomlands. Many rise in the Marseilles moraine and flow eastward down the moraine to the Lake Wauponsee flat, where they reverse to the west to conform with the general slope of the flat toward the outlet of Lake Wauponsee along Illinois Valley.

[5]Sauer, Carl O., Cady, Gilbert H., and Cowles, Henry C., Starved Rock State Park and its environs; Geographical Soc. Chicago Bull. 6, 1918.

# CHAPTER III—STRATIGRAPHY: GEOLOGIC PRINCIPLES

By
H. B. Willman

It requires only a brief examination to observe that the earth is composed of a considerable variety of rocks. The area described in this report, for example, is covered by unconsolidated rock such as clay, sand, and gravel, called *mantle rock*, and as may be seen where the mantle rock has been cut away along streams, it is underlain by relatively hard rock, called *bedrock*.

## TYPES OF ROCKS

Rocks are classified into three major types: (1) *igneous* rocks, which are formed by the solidification of molten rock material; (2) *sedimentary* rocks, which are formed by the deposition of rock fragments, organic debris, or chemical precipitates; and (3) *metamorphic* rocks, which are formed from igneous or sedimentary rocks by the action of intense heat, pressure, and solutions deep below the surface of the earth.

Rocks of all of these types are found in the Marseilles-Ottawa-Streator area. The exposed bedrock consists entirely of sedimentary rocks, such as sandstone, shale, and limestone, but igneous and metamorphic rocks occur below these, many thousands of feet deep. The mantle rock at the surface was formed by the accumulation of rock fragments and therefore is also sedimentary in origin. However, much of the mantle rock contains fragments of igneous and metamorphic rocks which were carried into the area by glaciers from far north regions where these rocks crop out.

### SEDIMENTARY ROCKS

Sedimentary rocks are characterized by their occurrence in beds. A sedimentary formation may consist of a single bed, but more commonly it consists of several beds or layers separated by planes of stratification. Only sedimentary rocks contain fossils, which are the remains or traces of prehistoric animals or plants. The three groups of sedimentary rocks are described below.

#### Clastic Rocks

The clastic sedimentary rocks are composed of rock fragments weathered or eroded from bedrock and transported and deposited by streams, wind, or glaciers. Streams drop their loads of detritus wherever they lose velocity, as they do on entering lakes or seas. The largest and heaviest materials are dropped first, the smallest last and consequently farthest from the source. Thus the rock fragments are graded by size and a deposit may grade from sand or gravel at the mouth of a stream to clay in the deep waters of the lake or sea.

Swirling winds move great quantities of sand, silt, and clay, which are more or less sorted by the wind. As the velocity of the wind diminishes, it drops the sand first and nearest the source and carries the finer material farther. The most easily floated small particles may be carried great distances.

Glaciers erode the materials over which they ride, incorporating rock debris of many kinds and sizes. When the ice melts the debris is left unsorted.

The unconsolidated clastic rocks are called *clay*, *silt*, *sand*, and *gravel*, depending on the size of the rock fragments, and when consolidated they become *shale*, *siltstone*, *sandstone*, and *conglomerate*. All gradations in the size of the rock fragments occur and it is necessary to select arbitrary limits separating them. The size limits used in this report, together with a more detailed discussion of the nomenclature of the clastic rocks, is given in appendix D, table 1.

### Organic Rocks

Organic sedimentary rocks are composed of the remains of organisms. *Coal* beds are formed almost entirely of plant debris. Many *limestones* consist largely of the calcareous shells of invertebrate animals. Some of the shells are preserved and occur as fossils in the rock but most of them were broken down to a fine lime mud before consolidation. In some limestones the calcium carbonate was replaced during deposition or immediately afterward by the mineral dolomite, which is calcium and magnesium carbonate, and the resulting rock is called *dolomite*. The process was not entirely completed in some of the rocks in the Marseilles-Ottawa-Streator area and so they consist of mixtures of limestone and dolomite and are called *dolomitic limestone*. Most of the limestones contain some fine clay and some of them grade into clastic sedimentary rocks, such as shale, with intermediate types variously called calcareous shales and clayey or argillaceous limestones.

### Chemical Precipitates

Some limestones, especially those which contain no fossils, have probably been formed by chemical precipitation of calcium carbonate. Much of the fine-grained material in the fossiliferous limestones may also be a chemical precipitate.

## IGNEOUS AND METAMORPHIC ROCKS

Igneous rocks differ from the sedimentary rocks in being usually harder and not stratified. They are of two major types—the coarse-grained rocks of which the familiar pink or gray granite is typical, and the fine-grained rocks of which the dark-colored kinds are commonly called *basalt* and the light-colored *felsite*.

Metamorphic rocks are of many types but the principal ones are *gneiss*, in which the different minerals are segregated in bands which resemble stratification but are usually much contorted; *schist*, which is composed largely of platy minerals, like mica; and *quartzite*, a metamorphosed sandstone in which the sand grains have been tightly interlocked by recrystallization and cementation with silica.

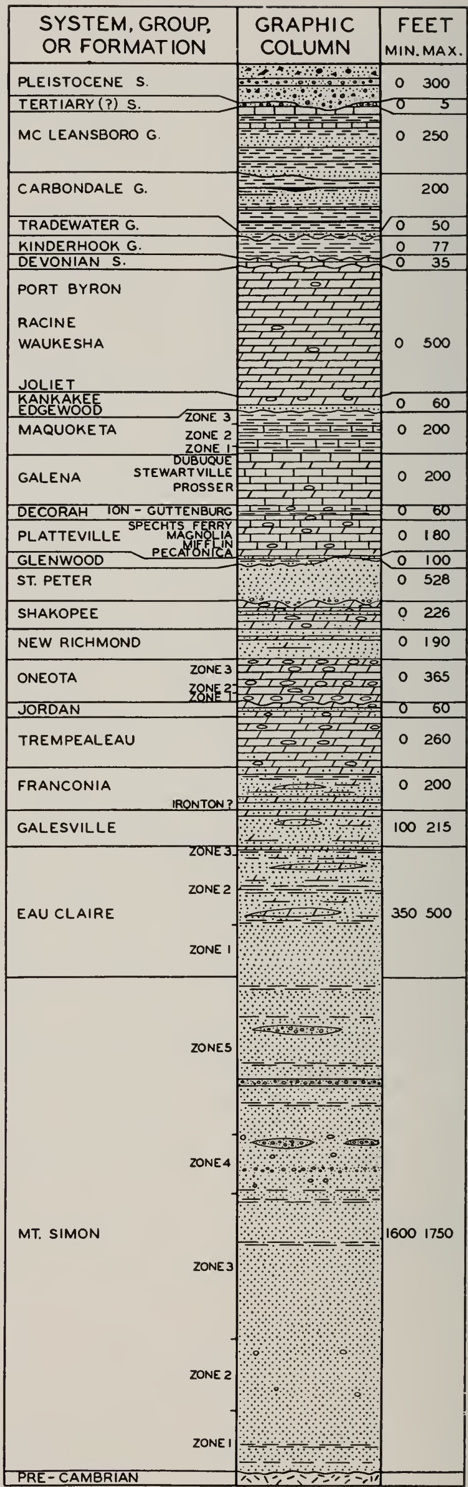



Fig. 31.—Columnar section of the rocks of the Ottawa, Marseilles, and Streator quadrangles.

Table 1—Geologic Column
(see fig. 31)

| Era | System | Series | Group | Formation | Material |
|---|---|---|---|---|---|
| CENOZOIC | Pleistocene | | | | Till, gravel, sand, silt, clay |
| | Tertiary | | | | Conglomerate and sandstone |
| PALEOZOIC | Pennsylvanian | | McLeansboro<br>Carbondale<br>Tradewater | | Sandstone, shale, clay, limestone, coal |
| | Mississippian | Iowa | Kinderhook | | Shale, brown |
| | Devonian | | | | Limestone, light gray |
| | Silurian | Niagaran | | Port Byron<br>Racine<br>Waukesha<br>Joliet | Dolomite and (or) some limestone |
| | | Alexandrian | | Kankakee<br>Edgewood | Dolomite and sandstone |
| | Ordovician | Cincinnatian | | Maquoketa | Shale and some dolomite or limestone |
| | | Mohawkian | | Galena<br>Decorah<br><br>Platteville<br>Glenwood | Dolomite and (or) limestone, light brown<br>Dolomite and (or) limestone with streaks of shale<br>Dolomite and (or) limestone<br>Sandstone, shale, and dolomite |
| | | Chazyan | | St. Peter | Sandstone, sometimes conglomeratic at base |
| | | Prairie du Chien | | Shakopee<br>New Richmond<br>Oneota | Dolomite with some thin sandstone beds<br>Sandstone and some dolomite<br>Dolomite, usually cherty |
| | Cambrian | St. Croixan | | Jordan<br>Trempealeau<br>Franconia | Dolomite, sandstone, and shale<br>Dolomite<br>Sandstone, dolomite, and shale; very glauconitic |
| | | | Dresbach | Galesville<br>Eau Claire<br>Mt. Simon | Sandstone with some dolomite<br>Sandstone, shale, and dolomite<br>Sandstone, arkosic in lower part; some shale and conglomerate |
| Pre-Cambrian | | | | | Crystalline rocks |

## FOSSILS

The fossils which occur in sedimentary rocks are of more than biologic interest. Some fossils are restricted to certain strata and so are important because they make it possible to identify these strata wherever they occur. Such fossils are known as *guide* or *index* fossils. The fossils found in the strata of Ordovician age in the Marseilles-Ottawa-Streator area are quite different from those in rocks of Pennsylvanian age and provide an easy means of differentiating them. Within the Pennsylvanian system the same fossils occur in many different layers and are not restricted in their vertical distribution so they are of little value in correlating beds at one place with those at another. Some strata, however, have a great predominance of one particular fossil or have a distinctive group of fossils, and this characteristic is of value in correlating them. Fossils also indicate the character of the environment in which the rocks were formed.

## STRATIGRAPHIC RELATIONS

The sequence of sedimentary rocks contains many different kinds of rocks. The contact between many of them is a gradational zone showing a gradual change in the type of material deposited. Even where the change in the kind of rocks is sharp there is usually no evidence of a break in deposition, and the change in character of the material deposited may have resulted from a variation in the depth of water, or from a change in the climate or elevation of the area supplying the sediments. Such strata are said to be *conformable* with each other. Between some beds, however, there is evidence of a break in deposition, an interval of erosion, and in these cases the beds are said to be unconformable and the break between them is called an *unconformity*. Unconformities are indicated by the presence of an irregular contact between the beds or by evidences of tilting and erosion of the lower beds before deposition of the upper. In some cases where the beds appear to be conformable, the actual existence of an unconformity is recognized by the absence of certain beds which are known to occur at that position elsewhere.

## CORRELATION

Many beds have uniform and distinctive lithologic characteristics by which they can be easily identified for long distances. Others, however, have no distinctive characteristics or grade laterally into other rock types. Correlation of such strata can be made if outcrops are sufficiently continuous or if guide fossils can be found, but lacking these, correlations can be made only by a careful study of the position of the bed in relation to others. Samples of drill-cuttings from wells are of value in making correlations in areas where the beds are deeply buried.

## NOMENCLATURE

Studies of the earth's crust have shown that certain unconformities found in the rocks are world-wide and mark intervals of great changes in life-forms as well as in the physical aspects of the continents. The intervals of time between these major events are called *eras*. Other less important world-wide breaks in the life and physical record serve to subdivide the eras into *periods* of time. The rocks formed during a period are called *systems*. The periods are subdivided into *epochs* of time and the systems of rocks into *series* and *groups*. Each series or group of rocks is composed of *formations*, and subdivisions of formations are called *members*. As explained later (p. 87) the groups of the Pennsylvanian system are subdivided into *cyclothems* rather than formations. The application of this nomenclature in the stratigraphic classification of rocks in the Marseilles-Ottawa-Streator area is shown in figure 31 and table 1.

# CHAPTER IV—SUBSURFACE STRATIGRAPHY

BY

J. Norman Payne

The bedrock in the Marseilles, Ottawa, and Streator quadrangles ranges in age from pre-Cambrian to Pennsylvanian. Although the bedrock is concealed over the greater part of the area by glacial drift, there are numerous more or less limited outcrops and a large number of well logs by means of which it is possible to obtain a fairly accurate picture of the relationships and characters of the pre-Pleistocene formations and of the structural conditions.

All of the formations of the Marseilles-Ottawa-Streator area, with the exception of pre-Cambrian formations, are composed of sedimentary rocks. Pre-Cambrian rocks do not crop out in Illinois. However, several wells drilled in the northern part of the State have penetrated red "granite" of pre-Cambrian age.

As the stratigraphy of the outcropping Ordovician and of the Pennsylvanian formations is covered in the succeeding chapters of this report, this one deals only with the characters and relationships of pre-Cambrian, Cambrian, Ordovician, and Silurian formations as revealed from a study of sample-cuttings and logs of various types of borings drilled throughout the area.

In order to obtain more adequate knowledge of these formations within the quadrangles the study was expanded to cover a much larger area, of which the quadrangles are approximately the center (fig. 1 and pls. 13-27)*, and it is this larger area that is meant wherever the words "the region" or "north-central Illinois" are used.

*The wells whose locations are shown on plates 13-27 are those which were drilled and for which records were available as of April 1, 1941. The available records of numerous wells that have been subsequently drilled confirm the areal distribution of the formations as shown on the plates.

## PRE-CAMBRIAN SYSTEMS

The well nearest to the Marseilles, Ottawa, and Streator quadrangles which penetrated pre-Cambrian strata is the Amboy Oil and Gas Company well on the McElroy farm in the SW. ¼ SW. ¼ NW. ¼ sec. 30, T. 20 N., R. 10 E., Lee County (app. C, 7). This well entered red "granite" at a depth of 3760 feet or an elevation of 3046 feet below sea-level. The upper part of the pre-Cambrian strata underlying north-central Illinois is probably composed of the same type of material as encountered in this well.

## CAMBRIAN SYSTEM[1]

The Cambrian rocks of the region, which are known only from study of well-cuttings, are of Upper Cambrian or St. Croixan[2] age. A study of the variations in thickness of some of the upper formations of the St. Croixan series indicates that its aggregate thickness ranges from a maximum of about 2800 feet in an east-west belt across the northern half of the Marseilles and Ottawa quadrangles to a minimum of 2500 feet in the northern part of the Streator and central parts of the Marseilles and Ottawa quadrangles (pls. 14, 16).

[1]The Cambrian system derives its name from Cambria, the Roman name for northern Wales, where the rocks of this system are typically exposed. Sedgwick, Rev. A., Edinburgh New Philos. Jour., vol. 19, p. 390, Aug. 14, 1835. Abst.

[2]The name St. Croixan was given to this series of rocks by N. H. Winchell from exposures along the St. Croix River, Minnesota. Winchell, N. H., Sketch of the Geology of Minnesota: Geol. and Nat. Hist. Survey of Minnesota, First Ann. Rept. for 1872, p. 70, 1873.

In ascending order Cambrian formations in the region are Mt. Simon, Eau Claire, Galesville, Franconia, Trempealeau, and Jordan formations.

### DRESBACH GROUP[3,4]

The Dresbach group consists of the Mt. Simon, Eau Claire, and Galesville formations. These formations are composed predominantly of sandstone with subordinate amounts of dolomite and shale.

#### Mt. Simon Formation[5]

*Distribution.*—Because the Mt. Simon sandstone has been penetrated to varying depths in several wells in and near north-central Illinois, and because it is several hundred feet thick throughout northern Illinois, it doubtless underlies the entire region.

*Lithology.*—In the McElroy well mentioned above (app. C, 7) in which the complete thickness of the Mt. Simon formation was penetrated, it consists of five fairly well defined zones as follows:

| | Ft. |
|---|---|
| *Zone 5.* Sandstone, pink to yellow, dominantly coarse-grained, interbedded with variegated micaceous shales and occasional conglomeratic layers | 545 |
| *Zone 4.* Sandstone, variegated, very fine- to coarse-grained, partly conglomeratic, interbedded prominently with purple and yellow granular conglomerate, with some purple sandy shale in the lower 20 feet | 195 |
| *Zone 3.* Sandstone, variegated, fine- to coarse-grained, partly silty, with some sandy, gray to brown shale at top | 490 |
| *Zone 2.* Sandstone, variegated, fine- to coarse-grained, containing scattered grains and pebbles of granite and feldspar | 260 |
| *Zone 1.* Sandstone, variegated, arkosic, medium- to coarse-grained, with some interbedded red to green micaceous shale in the lower half | 200 |

*Thickness.*—According to the variation in thickness of other Cambrian formations, the maximum thickness of the Mt. Simon formation is estimated to be about 1700 to 1750 feet in the north part of the Marseilles and Ottawa and the extreme south part of the Streator quadrangles, and the minimum to be probably about 1600 feet in the central and south parts of the Marseilles and Ottawa and the north part of the Streator quadrangles.

*Stratigraphic relations.*—The Mt. Simon sandstone rests unconformably on the eroded pre-Cambrian bedrock and is succeeded with probably slight disconformity by the Eau Claire formation.

*Correlation.*—On the basis of its lithology and stratigraphic position the Mt. Simon sandstone in north-central Illinois is correlated with the Mt. Simon formation of Wisconsin. However, because the character of the material in zone 1 suggests that it is of terrestrial origin, with the basal shale portion possibly representing weathered regolith of the pre-Cambrian formations, the zone may be older than the Mt. Simon and possibly equivalent, at least in part, to the Hinckley sandstone at Hinckley, Minnesota. The occurrence of scattered feldspar and granite in zone 2 is not contrary to this view, as the reworking of the materials in an advancing sea would distribute them for some time.

#### Eau Claire Formation[6]

*Distribution.*—The Eau Claire formation doubtless underlies the entire region, as there is no evidence of its nondeposition or of its complete removal by erosion in any part of the region.

*Lithology.*—The Eau Claire formation consists of dolomitic sandstones and shales and sandy dolomites which may be divided into three zones as follows:

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[3]The name Dresbach was first used in 1886 for sandstone quarried along Mississippi River at Dresbach, Minnesota. Winchell, N. H., Geology of Minnesota: Geol. and Nat. Hist. Survey of Minnesota, Final Report, vol. 2, preface, p. 22, 1888.

[4]In earlier reports on Illinois geology the sandstone lying between the Eau Claire formation below and the Franconia formation above was thought to be equivalent to the Dresbach sandstone at the type locality of Minnesota. Recently Trowbridge and Atwater (Stratigraphic Problems in the Upper Mississippi Valley: Geol. Soc. America Bull., vol. 45, pp. 21-80, Feb. 28, 1934) found that the type section of Dresbach includes part of the Eau Claire formation, and proposed that the Dresbach be expanded to include the Mt. Simon and the Eau Claire formations and that these as well as the upper sandstone, for which they proposed the name Galesville, be reduced to the rank of members. The Illinois Survey has accepted the name Galesville, but because of their magnitude and consistency it considers the Mt. Simon, Eau Claire, and Galesville as formations and the Dresbach as a *group*.

[5]The Mt. Simon formation derives its name from typical exposures in a bluff on Mount Simon at Eau Claire, Wisconsin. Walcott, C. D., Cambrian geology and paleontology: Smithsonian Misc. Coll., vol. 57, p. 354, 1914.

[6]The Eau Claire formation was named from the town of Eau Claire, Wisconsin, near which it is well exposed. Walcott, C. D., Cambrian geology and paleontology: Smithsonian Misc. Coll., vol. 57, p. 354, 1914.

| | Ft. |
|---|---|
| *Zone 3.* Dolomite, sandy, greenish-gray to gray, finely crystalline, locally argillaceous, containing shale and sandstone partings and beds; varies considerably in thickness . . . . . . . . | 5-30 |
| *Zone 2.* Sandstone, dolomitic, mostly pink, buff, and red, very glauconitic above the basal 40 to 50 feet; occurs in persistent beds very irregular in thickness, with green, red, and gray dolomitic silty shales, and gray, pink, and buff finely crystalline sandy generally glauconitic dolomite in beds that are probably lenticular. . . . . . . | 225-250 |
| *Zone 1.* Sandstone, gray, yellow, and buff, very fine- to coarse-grained, fossiliferous; individual grains covered with sooty black incrustations of finely divided pyrite; thickness very irregular | 100-170 |

*Thickness.*—The Eau Claire formation averages 450 feet thick in wells to the northeast and is probably the same in north-central Illinois. The maximum known thickness in the region is in the Rabbit No. 1 well in the NW. ¼ SE. ¼ SW. ¼ sec. 31, T. 20 N., R. 10 E., Lee County, where it is 493 feet thick (pl. 28, No. 8). Assuming that its thickness varies in the same manner and degree as the overlying Cambrian formations, it is probably thickest, possibly more than 500 feet, in the north part of the Ottawa and Marseilles and the extreme south part of the Streator quadrangles.

*Stratigraphic relations.*—The Eau Claire formation is slightly disconformable on the Mt. Simon sandstone, and although the contact with the overlying Galesville sandstone is sharp and disconformable there is no evidence of an erosional break between the two in well cuttings.

*Correlation.*—The Eau Claire formation is correlated with the Eau Claire formation of Wisconsin on the basis of lithology and stratigraphic position.

## Galesville Sandstone[7]

*Distribution.*—The Galesville sandstone has been penetrated in a number of wells and is doubtless present throughout north-central Illinois.

*Lithology.*—The Galesville sandstone is composed almost entirely of white, buff, and light gray fine- to coarse-grained sandstone, some of which is dolomitic, with local thin beds or lenses of buff, light gray, brown, and pinkish sandy dolomite. The compactness of the formation varies with the amount of dolomite as cementing material, for at Peru and Oglesby and in Grundy and Livingston counties, where dolomite is abundant in the sandstone, the formation appears to be more compact than in the vicinity of Ottawa where dolomite is less abundant.

*Thickness.*—The maximum thickness of the formation recorded within the quadrangles is 215 feet at Ottawa, which is in an area in the north part of the Ottawa and Marseilles quadrangles where the sandstone is apparently thickest. The formation is thinnest in the south part of the Ottawa and Marseilles and the north part of the Streator quadrangles where it averages 125 feet thick (pl. 14).

*Stratigraphic relations.*—The Galesville sandstone is disconformable on the underlying Eau Claire formation. The contact of the Galesville and the overlying Franconia is gradational in many places.

*Correlation.*— On the basis of similarities in lithology and stratigraphic position, the Galesville sandstone of north-central Illinois is believed to be equivalent to the Galesville sandstone of Wisconsin.

## Franconia Formation[8]

*Distribution.*—The Franconia formation underlies all of north-central Illinois.

*Lithology.*—The Franconia formation consists of variegated fine-grained dolomitic very glauconitic compact sandstone, interbedded with greenish, gray, pink, and buff finely crystalline sandy glauconitic dolomites, and gray, green, and red sandy glauconitic shales. Locally at the base of the formation there are beds of buff to red coarse-grained dolomitic

[7]The Galesville sandstone was named for its typical occurrence in a bluff on Beaver Creek near Galesville, Wisconsin. Trowbridge, A. C., and Atwater, Gordon I., Stratigraphic problems in the Upper Mississippi Valley: Geol. Soc. America Bull., vol. 45, p. 45, Feb. 28, 1934.

[8]The Franconia formation was named from exposures near the town of Franconia, Minnesota. Berkey, C. P., Geology of the St. Croix Dalles: Am. Geol., vol. 20, p. 373, 1897.

TABLE 2.—POSITION AND THICKNESS OF GLAUCONITIC ZONES IN THE TREMPEALEAU FORMATION IN WELLS IN AND NEAR THE MARSEILLES, OTTAWA, AND STREATOR QUADRANGLES.

| Company | Farm name and well No. | Location quarter section sec., T., R. | Zone One | | Zone Two | | Zone Three | | Formation thickness (Feet) |
|---|---|---|---|---|---|---|---|---|---|
| | | | Distance above base | Thick-ness (Feet) | Distance above base | Thick-ness (Feet) | Distance above base | Thick-ness (Feet) | |
| Amboy Oil & Gas | McElroy No. 1 | SW SW NW 30-20N-10E | At Base | 50 | 75 | 5 | ... | .. | 150 |
| E. Stevenson | Rabbit No. 1 | NW SE SW 31-20N-10E | At Base | 28 | .. | .. | 118 | 25 | 168 |
| E. Stevenson | Minick No. 1 | SW NW NE 16-19N-10E | At Base | 25 | No samples upper part | | | .. | 175 |
| Sewell Well | Peru City No. 5 | NE NE NE 20-33N-1E | At Base | 40 | .. | .. | 125 | 45 | 210 |
| Layne North Central—Sewell Well | Oglesby City No. 2 | NW NE NW 36-33N-1E | At Base | 40 | .. | .. | ... | .. | 230 |
| John Schomas | Ottawa Silica Company | NW SW NW 10-33N-3E | At Base | 32 | 80 | 35 | ... | .. | 217 |
| Layne North Central | Ottawa City No. 8A | NE NE SE 14-33N-3E | | | Glauconitic throughout | | ... | .. | 220 |
| Layne North Central | Ottawa City No. 8 | SW SW 1-33N-3E | At Base | 15 | 55 | 45 | 155 | 30 | 225 |
| J. P. Miller Artesian Well | Alton R. R. at Dwight | NE NW SW 9-30N-7E | ....... | .. | .. | .. | 170 | 67 | 260 |

sandstones which may be equivalent to the Ironton[9] member of Wisconsin.

*Thickness.*—The Franconia formation averages between 150 and 175 feet in thickness. The maximum thickness thus far found represented by samples is 190 feet in the Ottawa City well No. 8B (app. C, 24). However, drillers' logs indicate that the formation thickens to the south and may be more than 200 feet thick in the south part of the Streator quadrangle.

*Stratigraphic relations.*—The Franconia formation is apparently conformable on the underlying Galesville sandstone, and its contact with the overlying Trempealeau formation is gradational.

*Correlation.*—The Franconia formation of north-central Illinois is correlated with the Franconia formation of Minnesota on the basis of lithology and stratigraphic position.

### Trempealeau Formation[10]

*Distribution.*—The Trempealeau formation doubtless underlies all of north-central Illinois. It lies directly beneath the glacial drift in the vicinity of Sandwich, DeKalb County (pl. 13).

*Lithology.*—The Trempealeau formation consists of gray, buff, and pinkish finely crystalline cherty locally sandy dolomite, with a few lenses of buff medium-grained dolomitic compact sandstone. It contains quartz geodes, particularly near the base, as fragments are frequently found in samples of well-cuttings.

Three more or less discontinuous glauconite zones are found in wells in and near north-central Illinois as shown in table 2.

*Thickness.*—The average thickness of the Trempealeau formation in north-central Illinois is 200 feet. It is greatest in the north part of the Ottawa and Marseilles quadrangles, where it averages about 230 feet. The maximum thickness thus far penetrated in wells in the quadrangles is in the Ottawa city well No. 8B where it is 245 feet thick (app. C, 24). However, a total thickness of 260 feet was found in the Alton Railroad well at Dwight (app. C, 53).

*Stratigraphic relations.*—The Trempealeau formation is conformable with the underlying Franconia formation, the contact being one of gradation. It appears to be conformable also with the overlying Jordan formation wherever the latter is present, but along the Kankakee arch in southeastern DeKalb County the Trempealeau formation is probably overlain unconformably by the St. Peter sandstone.

*Correlation.*—The Trempealeau formation of Illinois is correlated with the Trempealeau formation of Wisconsin on the basis of similarities in lithology and stratigraphic position.

### Jordan Formation[11]

*Distribution.*—The Jordan formation is believed to underlie all of the Marseilles, Ottawa, and Streator quadrangles, but north and northeast of them it is absent over the crest of the Kankakee arch. It is absent in the Sandwich village well No. 2 (app. C, 4), which is believed to be located almost on the crest of the arch, and there is also a pronounced thinning of the Jordan-Trempealeau-Franconia formations toward the axis of the Kankakee arch (pl. 16). In the vicinity of Batavia and Elgin in Kane County the Jordan is also absent, chiefly because of pre-St. Peter erosion.[12]

*Lithology.*—The Jordan formation in north-central Illinois consists dominantly

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[9]The Ironton was named from the village of that name in Wisconsin. Ulrich, E. O., Notes on new names in the table of formations and the physical evidence of breaks between Paleozoic systems in Wisconsin: Wisconsin Acad. Sci. Trans., vol. 21, pp. 93-94, 1924.

[10]The name Trempealeau is derived from Trempealeau Bluff along Mississippi River in Wisconsin. Ulrich, E. O., Notes on new names in the table of formations and on physical evidence of breaks between Paleozoic systems in Wisconsin: Wisconsin Acad. Sci. Trans., vol. 21, pp. 79-90, 1924.

[11]The Jordan formation was named for strata exposed in the town of Jordan, Scott County, Minnesota. Winchell, N. H., Geology of the Minnesota Valley: Geol. and Nat. Hist. Survey of Minnesota, Second Ann. Rept. for 1873, p. 149, 1874. In Wisconsin the Jordan is considered to be only a member of the Trempealeau formation (Twenhofel, W. H., Raasch, G. O., and Thwaites, F. T. Cambrian strata of Wisconsin: Geol. Soc. America Bull., vol. 46, no. 11, pp. 1709-1710, Nov. 30, 1935), but because of its magnitude and consistency and because of the marked stratigraphic break at its base the Illinois Survey classifies it as a formation.

[12]Gries, J. P., Subsurface geology of Barrington, Elgin, Geneva quadrangles: unpublished manuscript, Illinois Geol. Survey.

of dolomite with some interbedded shale and sandstone. The dolomite is sandy, cherty, white, pink, light gray, and green, and finely crystalline. Pink to buff sandy oölitic dolomite is found locally. The shale, when present, is dolomitic, vari-colored, and sometimes micaceous. The sandstone, which is usually found in the basal part of the formation, is dolomitic, white and light gray, finely to coarsely granular, and mostly compact.

*Thickness.*—The maximum known thickness of the Jordan formation within the Marseilles, Ottawa, and Streator quadrangles is 53 feet, in the Ottawa Silica Company well (app. C, 26), and the minimum is 25 feet, in the R. N. Peddicord well north of Marseilles (app. C, 15), but in the surrounding area the formation ranges from 0 to 60 feet in thickness.

*Stratigraphic relations.*—The contact of the Jordan formation with the underlying Trempealeau formation is sometimes gradational, but in some localities it is quite sharp. Its contact with the overlying Oneota dolomite is one of distinct unconformity, as shown by rapid and large variations in thickness of the Jordan formation. There also may be locally a conglomerate at the base of the Oneota formation.

Within the Marseilles, Ottawa, and Streator quadrangles the Jordan formation is everywhere overlain by the Oneota formation, but northward in Kendall and DeKalb counties it is probably overlain with angular unconformity by the St. Peter sandstone along the Kankakee arch.

*Correlation.*—The Jordan formation of this region is correlated with the Jordan formation of Minnesota mainly on the basis of similar stratigraphic position, but there are also lithologic similarities.

## ORDOVICIAN SYSTEM[13]

The Ordovician rocks of Illinois are divided into four series as follows: Prairie du Chien, represented by the Oneota, New Richmond, and Shakopee formations; the Chazyan, represented by the St. Peter sandstone; the Mohawkian, consisting of the Glenwood,[14] Platteville, Decorah, and Galena formations; and the Cincinnatian, represented by the Maquoketa shale. The maximum thickness of the Ordovician strata in this region is approximately 1200 feet.

### PRAIRIE DU CHIEN SERIES[15]

#### ONEOTA DOLOMITE[16]

*Distribution.*—The Oneota formation is believed to underlie all of the Marseilles, Ottawa, and Streator quadrangles, but at Mendota in LaSalle County, at Plano in Kendall County, and at Morris in Grundy County (pl. 28, Nos. 3, 11, 17; app. C, 11, 17), the formation was deeply eroded in pre-St. Peter time, and along the crest of the Kankakee arch it is entirely absent (pls. 13, 17).

*Lithology.*—The Oneota formation consists of light gray, white, and buff, occasionally red and pink, finely to coarsely crystalline dolomite. Well-cuttings show considerable amounts of white and yellow generally oölitic chert, which probably occurs as lenses, nodules, and interbedded layers in the dolomite. The lithologic characters vary little over the entire area, but in some wells there is a basal conglomeratic-appearing layer of yellow, white, and pink chert mixed with sand and some clay.

Excluding the basal conglomeratic layer the formation can be divided into

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[13]The name Ordovician was derived from Ordovices, the Roman name for a tribe of people that inhabited Wales where these rocks are typically exposed. Lapworth, C., On the Tripartite classification of the lower Paleozoic rocks: Geol. Mag., London, new series, vol. 6, pp. 12-14, 1879.

[14]The Glenwood was considered by some geologists to be of Chazyan age, but recent studies have shown it to be Mohawkian. For complete arguments see:

Stauffer, C. R., Conodonts of the Glenwood beds: Geol. Soc. America Bull., vol. 46, no. 1, pp. 125-168, Jan. 31, 1935.

Kay, G. Marshall, Ordovician System in the upper Mississippi Valley: Guidebook of Ninth Ann. Field Conference, Kansas Geol. Soc., pp. 285-286 and 288, 1935.

Elder, Stanley G., Stratigraphy of the Glenwood formation: unpublished manuscript, Illinois Geol. Survey.

[15]The Prairie du Chien was named from a series of exposures at Prairie du Chien, Crawford County, Wisconsin. Bain, H. F., Zinc and lead deposits of the upper Mississippi Valley: U. S. Geol. Survey Bull. 294, p. 18, 1906 (cites Lancaster-Mineral Point folio).

Grant, U. S., and Burchard, E. F., U. S. Geol. Survey Geol. Atlas Lancaster-Mineral Point folio (No. 145), p. 3, 1907.

[16]The name Oneota was derived from exposures along the Oneota (Upper Iowa) River in northeastern Iowa. McGee, W. J., Pleistocene history of northeastern Iowa: U. S. Geol. Survey Eleventh Ann. Report, pt. 1, p. 333, 1891.

three zones of variable thickness as follows:

| | Ft. |
|---|---|
| *Zone 3.* Dolomite, cherty, white, light gray, and buff, finely crystalline, with the upper 20 to 50 feet sometimes sandy or containing sandstone lenses; chert is dense, oölitic, white and yellow. | 110-210 |
| *Zone 2.* Dolomite, cherty, glauconitic, partly sandy, white, light gray, buff, and pink, finely crystalline . . . . . | 5-25 |
| *Zone 1.* Dolomite, cherty, slightly sandy, light gray, buff, pink-spotted, and chert, dense, oölitic, white and yellow. | 20-50 |

*Thickness.*—The greatest thickness of the Oneota formation penetrated in the Marseilles, Ottawa, and Streator quadrangles is 265 feet in the R. N. Peddicord well near Marseilles (app. C, 15), and the minimum thickness of 130 feet is found in the Ottawa Silica Company well (app. C, 26). In the quadrangles the formation is thickest in a belt extending in a southwesterly direction through the central portion of the Marseilles, the south-central and southwestern parts of the Ottawa, and the northwestern part of the Streator quadrangles and is thinner in the northern part of the Ottawa, the northern and southern parts of the Marseilles, and most of the Streator quadrangles.

The thickness of the formation varies more outside of the quadrangles than within, as it is 365 feet thick (the maximum recorded thickness) in the Alton Railroad well at Dwight (app. C, 53), is only 117 feet thick in the Mendota city well (app. C, 11), and is absent in the Sandwich village wells (app. C, 4) and in an area in the vicinity of Sandwich (pls. 13, 17). The formation thickens in two zones, one three to eight miles wide trending southwest from the northwest corner of Grundy County to the southwest corner of LaSalle County, and the other in east Livingston County (pl. 17).

*Stratigraphic relations.*—The Oneota dolomite rests unconformably on the Jordan formation.

Where the Oneota formation is overlain by the New Richmond sandstone in normal sequence, the two formations are apparently conformable, but a major unconformity above the Oneota formation occurs in eastern Livingston and in southern Kendall, DeKalb, and Lee counties and northern LaSalle County where it is succeeded directly by the St. Peter sandstone (pls. 13, 17, 18, 20, 21), all of the New Richmond and Shakopee formations and part of the Oneota formation having been removed by pre-St. Peter erosion.

*Correlation.*—The Oneota formation in north-central Illinois is correlated with the Oneota formation of Iowa on the basis of similar lithology and stratigraphic position.

### New Richmond Formation[17]

*Distribution.*—The New Richmond formation is present in the Marseilles, Ottawa, and Streator quadrangles but is absent over the higher part of the Kankakee arch in DeKalb, Kendall, and Lee counties and in northern LaSalle County and also along deep pre-St. Peter channels in Grundy and southeastern Livingston (pl. 18) counties. It crops out more or less continuously along Fox River south of Sheridan, from about the center of sec. 5 to the NE. corner of sec. 18, T. 35 N., R. 5 E., LaSalle County.

*Lithology.*—The New Richmond formation consists dominantly of white or light gray to buff, fine- to coarse-grained, partly dolomitic, generally incoherent and porous sandstone, containing some white siliceous oölites. In the western part of the region the sandstone is dolomitic, particularly in the lower 30 to 40 feet. At or near the base of the formation in the western part of the Ottawa quadrangle there is a fairly persistent horizon of sandy, usually cherty, light gray to buff dolomite. Eastward this zone appears to grade into a zone of white dolomitic sandstone.

In some wells the basal part of the formation is red, blue, and gray shale.

*Thickness.*—According to available information the New Richmond sandstone attains its greatest thickness in the vicinity of LaSalle, where a number of wells penetrated more than 160 feet of the formation. The maximum recorded thickness is 190 feet (app. C, 30), in a well at Starved Rock Park. The formation is thinnest in a belt about 10 miles wide

[17]The New Richmond formation is named from exposures in the vicinity of the village of New Richmond, St. Croix County, Wisconsin. Wooster, L. C., Geology of the lower St. Croix district: Geology of Wisconsin, vol. 4 p. 106, 1882.

running southwest from Kendall County. Between this belt and the truncation of the formation along the Kankakee arch in northern LaSalle County on the one side and the pre-St. Peter channels in Livingston and Grundy counties on the other side are belts in which the formation is thicker (pls. 18, 21).

*Stratigraphic relations.*—The New Richmond formation appears to be conformable both on the Oneota dolomite below and with the Shakopee formation which overlies it in normal sequence. However, a major unconformity occurs above the New Richmond sandstone along the southwest limb of the Kankakee arch in LaSalle and Kendall counties and along narrow strips in Grundy and Livingston counties where pre-St. Peter erosion removed the Shakopee formation, so that the New Richmond formation is overlain directly by the St. Peter sandstone.

*Correlation.*—The New Richmond of north-central Illinois is believed to be the stratigraphic equivalent of the sandstone that crops out in the vicinity of the village of New Richmond, Wisconsin.

### Shakopee Formation[18]

*Distribution.*—The Shakopee formation underlies all of the Marseilles, Ottawa, and Streator quadrangles but is absent over the Kankakee arch and along pre-St. Peter channels in Grundy and Livingston county (pl. 20). Outcrops of the Shakopee are found along Fox River from the center of the W. ½ sec. 8 to about the center of sec. 18, T. 35 N., R. 5 E., Kendall County, and along Illinois and Little Vermilion rivers and their tributaries north and east of LaSalle[19] (pl. 13). It also occurs below a thin cover of gravel and sand in the bed of Illinois River at Starved Rock in the Ottawa quadrangle and directly underlies glacial drift in the north part of the Marseilles quadrangle. Other outcrops of strata that may be Shakopee occur along Fox Valley near Millington (1) in and around Brodie's quarry in the SW. ¼ NE. ¼ sec. 19, T. 36 N., R. 6 E., Kendall County; (2) in an old quarry in the NE. ¼ NW. ¼ sec. 30, T. 36 N., R. 6 E., Kendall County; and (3) along the Chicago, Burlington and Quincy Railroad, in an adjacent old quarry, and along the river bluffs in the north-central part of sec. 36, T. 36 N., R. 5 E., LaSalle County (pl. 13).

*Lithology.*—The Shakopee formation is composed of dolomite with lenses or thin beds of sandstone and shale. The amount of clastic material in the formation is greater in the north and east parts than in the central, south, and west parts of the region. In the vicinity of Marseilles, well-cuttings of the Shakopee formation contain as much as 25 per cent of sandstone and shale.

The dolomite is buff to light brown and gray, finely to medium crystalline, generally sandy, and contains oölitic white chert. Locally, red silty argillaceous dolomite occurs in a horizon 75 feet above the base. The sandstones are dolomitic, light gray, buff and white, fine- to coarse-grained, and compact. Occasionally there are layers of dolomitic gray shale.

*Thickness.*—The regional variation in thickness of the Shakopee formation is the same as that of the New Richmond sandstone. The formation is thinnest in a belt about ten miles wide extending southwest from Kendall County. Between this belt and the truncation of the formation along the Kankakee arch in northern LaSalle County on the one side and the pre-St. Peter channels in Livingston and Grundy counties on the other are belts in which the formation is thicker (pl. 20). The maximum recorded thickness is 226 feet in the well at Chenoa (pl. 28, No. 56).

[18]The Shakopee formation derives its name from exposures near the village of Shakopee, Scott County, Minnesota. Winchell, N. H., Geol. and Nat. Hist. Survey of Minnesota, Second Ann. Rep. for 1873, p. 138-139, 1874.

Some geologists contend that the name Shakopee should not be used for this formation, as they believe that the strata at Shakopee are of Oneota age and they propose that Willow River, another name applied to the same beds, (Wooster, L. C., Geology of the Lower St. Croix District: Geol. Wisconsin, vol. 4, p. 106, 1882) be substituted. (Trowbridge, A. C., and Atwater, G. I., Stratigraphic problems in the Upper Mississippi Valley: Geol. Soc. America Bull., vol. 45, pp. 65-73, 1934.) Even if the strata at Shakopee are Oneota, which has not been established, the question remains as to whether the name Shakopee is still not valid because of its long usage and application to a formation whose identity and stratigraphic position were established and recognized elsewhere when the name was proposed.

Other papers on this subject are:

Couser, C. W., Paleozoic stratigraphy and structure in the Minnesota River Valley: Geol. Soc. America Proceedings for 1933, Abst., p. 383, 1934.

Powers, Elliot H., Stratigraphy of the Prairie du Chien: Guidebook of Ninth Annual Field Conference, Kansas Geol. Soc., p. 390, 1935.

Stauffer, C. R., Type Paleozoic sections in the Minnesota Valley: Jour. Geology, vol. 42, pp. 347-352, 1934.

Stauffer, C. R., et al, Guidebook of Ninth Annual Field Conference, Kansas Geol. Soc., pp. 171-173, 1935.

[19]Cady, G. H., Geology and Mineral Resources of the Hennepin and LaSalle Quadrangles: Illinois Geol. Survey Bull. 37, pp. 35-36, pls. I, II, 1919.

*Stratigraphic relations.*—The Shakopee dolomite is underlain conformably by the New Richmond sandstone and is succeeded unconformably by the St. Peter sandstone. Erosion preceding the deposition of the St. Peter formation developed a very uneven surface on the Shakopee formation which may be seen in outcrops near Utica and Dixon[20] and is indicated elsewhere by the large local variations in the thickness of the Shakopee formation, as revealed by wells. Narrow belts in which the formation is very thin or absent appear to be pre-St. Peter stream channels.

*Correlation.*—The Shakopee formation of north-central Illinois is correlated with the Shakopee formation of Minnesota on the basis of similarity of lithology and stratigraphic position.

## CHAZYAN SERIES[21]

### St. Peter Formation[22]

*Distribution.*—The St. Peter sandstone underlies all of the Marseilles, Ottawa, and Streator quadrangles except (1) a small area of the Illinois River floodplain near Starved Rock in the Ottawa quadrangle where the sandstone has been completely eroded and the Shakopee dolomite underlies the river deposits (pls. 13, 21) and (2) two small areas along the north edge of the Marseilles quadrangle. These two exceptions are parts of larger areas where the St. Peter formation is absent on the LaSalle and Kankakee anticlines.

Numerous exposures of the St. Peter occur in the Ottawa and Marseilles quadrangles (pls. 1, 2, 11, and p. 71) and also in the vicinity of LaSalle.[23]

*Lithology.*—The St. Peter formation is a white to light gray and buff fine- to coarse-grained friable sandstone (p. 73). Locally the basal few feet, called by well drillers the St. Peter "cave", consists mainly of variegated sandy partly dolomitic shales, containing pebbles of yellow, white, and red partly oölitic chert ranging in size up to 4 mm., with some beds of buff conglomeratic sandstone. This basal zone is thicker in the eastern part of the area, where pre-St. Peter erosion seems to have been greater, than in the western and central portions of the region. It crops out a short distance west of the Ottawa quadrangle.[24]

*Thickness.*—The St. Peter formation varies greatly in thickness (pl. 21). Its variations of greatest magnitude, such as the maximum reported thickness of 578 feet in the Morris City well No. 4 (app. C, 17) as compared with thicknesses 200 to 400 feet less in other wells nearest to it, are interpreted as the result of filling in pre-St. Peter river channels, but its more numerous local variations of lesser magnitude result from post-St. Peter erosion, some of it pre-Platteville, much of it pre-Pennsylvanian, and a considerable amount of it pre-Pleistocene, depending on which formation overlies it.

*Stratigraphic relations.*—The St. Peter sandstone lies unconformably on the Shakopee dolomite in the Marseilles, Ottawa, and Streator quadrangles, but to the north and east it lies directly on successively lower strata down to the Trempealeau formation.

Its contact with overlying strata is also unconformable. In extreme western and southern LaSalle, most of Lee, and all of Bureau, Putnam, Marshall, Woodford, and Livingston and southern Grundy counties, it is regularly succeeded by the Glenwood formation, but from the study of outcrops it has been determined that it is directly succeeded by the Pecatonica (basal) member of the Platteville formation at three localities—(1) sec. 35, T. 35 N., R. 1 E., at Troy Grove, (2) in the N. ½ sec. 27, T. 34 N., R. 1 E., four miles north of LaSalle, and (3) in the NW. ¼ NW. ¼ sec. 31, T. 33 N., R. 2 E., at Deer Park—showing the absence of the Glenwood formation at these places. Farther east, in secs. 21 and 22, T. 33 N., R. 2 E., in Starved Rock State Park and in secs. 16, 21, and 27, T. 33 N., R. 3 E., the St. Peter sandstone is directly over-

[20]Cady, G. H., op. cit., p. 36.
Knappen, R. S. Geology and mineral resources of the Dixon Quadrangle: Illinois Geol. Survey Bull. 49, pp. 47-48, 1926.

[21]The Chazyan series was named from the Chazy limestone group of eastern New York. Grabau, A. W., Physical and faunal evolution of North America during Ordovicic, Siluric, and early Devonic time: Jour. Geology vol. 17, pp. 209-252, 1909.

[22]St. Peter is the name applied to the sandstone that crops out along Minnesota (St. Peter's) River, Minnesota. Owen, D. D., Report of a geological reconnaissance of the Chippewa land district of Wisconsin and the northern part of Iowa: U. S. 30th Congr., 1st sess., Sen. Exec. Doc. 57, pp. 27-31, 1848.

[23]Cady, G. H., op. cit., pls. I, II.

[24]Cady, G. H., op. cit., pp. 37 and 39.

lain by the Mifflin member of the Platteville formation,[25] revealing that not only the Glenwood formation but also the Pecatonica member of the Platteville are absent. This shows a successive overlap by the Platteville formation on the St. Peter from west to east.

Along Illinois Valley and the valley of Covel Creek near Ottawa, channels in the top of the St. Peter as much as 20 feet deep and nearly a mile wide are filled with Platteville limestone (pl. 13). These depressions are believed to be remnants of pre-Platteville valleys which trend north-south as indicated by the alignment of Platteville outliers southwest of Ottawa (pls. 13, 28). Similar pre-Platteville channeling is indicated by the extreme irregularity of the St. Peter surface in LaSalle County east of Marseilles and in northwestern Grundy County in the vicinity of Morris (pl. 22), where it is overlain by the Galena-Platteville formations.

In the central and southwest parts and along the northern border of the Ottawa and in most of the west and central parts of the Marseilles quadrangles (pl. 13) the St. Peter sandstone is in direct contact with Pennsylvanian strata, all of the intervening strata having been removed by pre-Pennsylvanian erosion which also developed on the St. Peter sandstone a very irregular surface of relatively low relief. In the north and northwest parts of the Ottawa and Marseilles quadrangles and in southwestern Kendall, northern LaSalle, and in southeastern Lee Counties, the St. Peter sandstone is directly succeeded by Pleistocene formations (pl. 13) and in these areas it has a very irregular surface developed by preglacial erosion.

*Correlation.*—The St. Peter sandstone of north-central Illinois is correlated with the type section in Minnesota on the basis of similarities in lithology and stratigraphic position.

## MOHAWKIAN SERIES[25a]

### Glenwood Formation[26]

*Distribution.*—The Glenwood formation is apparently present in all of the region except the north-central part, which includes all of the Marseilles and Ottawa and the north part of the Streator quadrangles. Wherever the St. Peter and older formations lie directly under Pennsylvanian strata or glacial till (pl. 13) the absence of the Glenwood formation could be ascribed to pre-Pennsylvanian or preglacial erosion, but the overlap of successively younger Platteville strata on the St. Peter sandstone (p. 61) in the vicinity of Illinois River from LaSalle to Marseilles is evidence that in that area the Glenwood formation was never deposited.

*Lithology.*—The Glenwood consists normally of an upward succession of sandstone, shale, and dolomite. The sandstone, ranging in thickness from 0 to 73 feet, is partly dolomitic, white, buff, and gray, fine- and coarse-grained, with occasional lenses of shale or dolomite or both, especially where it is exceptionally thick. The shale overlying the sandstone is sandy, somewhat dolomitic, and brown, green, and gray. It is rarely more than 10 feet thick and is frequently absent. The dolomite is gray, brown, buff, and green, very finely crystalline, and compact. The dolomite of the Glenwood formation is distinguishable from the basal sandy dolomite of the overlying Platteville formation in that it is argillaceous and has an earthy appearance, whereas the basal Platteville is not argillaceous and has a sugary appearance.

The sandstone of the Glenwood formation is distinguishable from the underlying St. Peter sandstone because it has a larger percentage of finer material and a distinct break in grade size from fine to coarse. It also has a relatively large proportion of garnet in contrast to the rare occurrence of garnet in the St. Peter formation.[27]

The heavy minerals most abundant in the Glenwood sandstone are garnet, tourmaline, and zircon. Rutile, ilmenite, epidote, zoisite, hornblende, chlorite,

[25]Templeton, J. S., personal communication.

[25a]The Mohawkian derives its name from a series of rocks exposed along the Mohawk River in New York. Clarke, J. M. and Schuchert, C., The nomenclature of the New York series of geological formations: Sci. n.s., vol. 10, pp. 876-877, 1899.

[26]The Glenwood was named from exposures at Glenwood, Winneshiek County, Iowa. Calvin, Samuel, Geology of Winneshiek County: Iowa Geol. Survey, vol. 16, pp. 60-61 and 74-75, 1906.

[27]Thiel, Geo. A., Petrographic analysis of the Glenwood beds of southeastern Minnesota: Geol. Soc. America Bull., vol. 48, No. 1, p. 119, 1937.

fluorite, biotite, muscovite, tremolite, ceylonite, anatase, sphene, staurolite, and corundum occur in smaller amounts.[28]

The relatively large amount of garnet in the Glenwood sandstone in contrast to that in the St. Peter and the presence of fresh-appearing non-rounded quartz grains indicate weathering and erosion of crystalline rocks on the land surface bordering the Glenwood sea, with consequent contribution of garnet and quartz to the sediments.[29] The most logical source of materials was the pre-Cambrian shield which lay to the north. A large percentage of the coarse sand grains of the Glenwood was probably derived from the St. Peter sediments, either by reworking of the St. Peter sand on the sea-floor or by addition of the sand from St. Peter sediments then exposed to erosion.

*Thickness.*—In drillers' logs the Glenwood is usually not separable from the St. Peter sandstone, so its thickness may be determined only from the records of the few wells from which samples of cuttings have been preserved and studied. The Glenwood is usually about 15 feet thick but is 80 feet thick in southeastern Lee County and 100 feet thick at Gardner in Grundy County (app. C, 7, 42; pl. 28, No. 8).

*Stratigraphic relations.*—Recent studies have shown the Glenwood formation to be unconformable on the underlying St. Peter formation.[30] This view is supported by the overlap of the Glenwood and Platteville beds on the St. Peter sandstone (p. 61). The contact of the Glenwood with the overlying Platteville is sharp, although the basal Platteville beds usually contain some sand.

*Correlation.*—The Glenwood formation in north-central Illinois is correlated with the Glenwood formation of Iowa on the basis of similarity in lithology and stratigraphic position. The Iowa Glenwood is correlated with the Lowville of the New York section.[31]

[28]Thiel, Geo. A., op. cit. pp. 117-121.
Tyler, S. A., Heavy minerals of the St. Peter sandstone in Wisconsin: Jour. Sedimentary Petrology, vol. 6, pp. 55-84, 1936.

[29]Elder, Stanley G., Stratigraphy of the Glenwood formation: Illinois Geol. Survey, unpublished ms.

[30]Elder, Stanley G., op. cit.

[31]Kay, G. M., The Ordovician system in the Mississippi Valley: Guidebook of the 9th Ann. Field Conference Kansas Geol. Soc., p. 288, 1935.

## Platteville Formation[32]

The Platteville formation is divided into members which are, in ascending order, the Pecatonica, the Mifflin, the Magnolia, and the Spechts Ferry.[33] The separation into members, based on the study of well-cuttings, is difficult and uncertain, and therefore the Platteville in this report is discussed as a unit.

*Distribution.*—The Platteville formation underlies all of the region except an irregular area in the north-central part (pl. 13). It is present also in small outliers west and southwest of Ottawa in T. 33 N., R. 3 E., and in secs. 21, 22, and 29, T. 33 N., R. 2 E., and may possibly underlie the greater part of T. 33 N., R. 2 E., or be represented by numerous outliers in this part of the region. The boundary of the Galena-Platteville in this township and the next township east has been question-marked to indicate the uncertainty of mapping, owing to lack of data (pl. 13).

Strata belonging to the Pecatonica member are found (1) at Troy Grove in sec. 35, T. 35 N., R. 1 E., (2) in the N. ½ sec. 27, T. 34 N., R. 1 E., four miles north of LaSalle, and (3) at Deer Park in the NW. ¼ NW. ¼ sec. 31, T. 33 N., R. 2 E. Strata belonging to the Mifflin member are found (1) in secs. 21 and 22, T. 33 N., R. 2 E., at Starved Rock State Park, (2) in secs. 16, 21, and 27, T. 33 N., R. 3 E., and (3) at Deer Park. No strata belonging to the Magnolia and Spechts Ferry members have been recognized in outcrops, although these members are doubtless present in parts of the region where the Platteville attains its full thickness.[34]

[32]The Platteville formation was named from typical exposures near the town of Platteville, Wisconsin. Bain, H. F., Zinc and lead deposits of northwestern Illinois: U. S. Geol. Survey Bull. 246, p. 19, 1905.

[33]The Pecatonica was named from exposures along the Pecatonica valley, Wisconsin. Hershey, O. H., The Elk Horn Creek area of sandstone: Am. Geologist, vol. 14, p. 175, 1894.
The Mifflin derives its name from outcrops in the east edge of Mifflin, Iowa County, Wisconsin. Bays, C. A., Stratigraphy of the Platteville formation: Unpublished Ph.D. thesis, Univ. of Wisconsin, 1937.
The Magnolia member was named from exposures one mile south of Magnolia, Rock County, Wisconsin. Bays, C. A., and Raasch, G. O., Mohawkian relations in Wisconsin: Guidebook of the 9th Ann. Field Conference Kansas Geol. Soc., p. 298, 1935.
The Spechts Ferry member was named from exposures in a ravine near Spechts Ferry, Dubuque County, Iowa. Kay, G. M., Divisions of the Decorah formation: Science, vol. 67, p. 16, 1928

[34]Templeton, J. S., personal communication.

*Lithology.*—The Platteville formation consists of brown, buff, and gray very finely crystalline compact dolomite and fossiliferous brown and gray very finely granular to lithographic dolomitic limestone, which in well-cuttings have a characteristic mottled appearance. At various horizons, but chiefly in the upper part of the formation, there are lenses, nodules, and beds of brown, gray, and white, translucent to opaque, somewhat chalcedonic chert. The lower 5 to 15 feet of the formation consists of brown very finely crystalline sandy dolomite or dolomitic limestone.

The distribution of the dolomite or limestone is related not stratigraphically to horizons in the formation but geographically to the major structures. The dolomite content increases toward the crests of the LaSalle anticline, the Kankakee and Wisconsin arches, and other anticlines, and the formation may be almost entirely dolomite on some of the higher parts of these structures. The limestone and dolomite areas are not sharply separated but grade one into the other.

The characters that distinguish the Platteville from the overlying Decorah and Galena formations in well-cuttings in this region are (1) the very finely crystalline or granular or lithographic texture, (2) the usually mottled color, (3) the compactness of the formation where it is a dolomite, and (4) the general absence of shaly partings.

*Thickness.*—As the Galena, Decorah, and Platteville formations are not separable in drillers' logs, their combined thickness is shown on one map (pl. 23). However, they can be distinguished by studies of well-cuttings which are available for 23 wells in the region, and from these some idea of the thickness of each formation may be obtained. The Platteville probably attains thicknesses of between 125 and 140 feet along the eastern and southern borders of the Marseilles quadrangle and over most of the Streator quadrangle. The greatest thickness so far obtained in drilling within the region was 180 feet in the village of Fairbury well No. 3 (app. C, 57). Disregarding small local variations in thickness the formation thickens progressively from north to south at a rate of about 0.9 foot per mile and also from west to east although not nearly as rapidly.

*Stratigraphic relations.*—The Platteville formation is underlain with apparent conformity in parts of the region by the Glenwood formation and unconformably by the St. Peter sandstone in other parts (p. 61).

The contact of the Platteville and the overlying Decorah formations is usually gradational and very difficult to determine. However, in the south part of the Ottawa and Marseilles quadrangles and in west and central Grundy County the Platteville formation is overlain unconformably by Pennsylvanian strata. Where the Platteville-Pennsylvanian unconformity is exposed, in the vicinity of Ottawa, it has a relief of only about 5 feet, but from records of wells it is evident that elsewhere the relief is much greater (pls. 23 and 24).

The Platteville formation is covered directly by glacial deposits in parts of all three quadrangles (pl. 13) and in northern Grundy, southeastern Kendall, northwestern LaSalle, and part of southeastern Lee counties.

*Correlation.*—On the basis of lithology, fossil content (app. G, table 1), and stratigraphic position the Platteville formation of this region is correlated with the Platteville formation of Wisconsin. The Spechts Ferry member has been correlated with the so-called "Decorah shale" of Missouri, and the lower beds have been correlated with the upper Plattin beds of Missouri.[35]

### Decorah Formation[36]

The Decorah formation consists of two members, the Ion and Guttenberg, but it is not possible to separate these members in well-cuttings, so it is considered as a single unit.

*Distribution.*—The Decorah formation is present in all of the region except the north-central part. It underlies glacial drift or Pennsylvanian strata in a narrow

[35]Kay, G. M., The Ordovician system in the Upper Mississippi Valley: Guidebook of the 9th Ann. Field Conference Kansas Geol. Soc., p. 288, 1935.

[36]The Decorah formation was named from exposures at the village of Decorah, Winneshiek County, Iowa. Calvin, Samuel, op. cit., pp. 60-61, 84-85.

belt that probably coincides roughly with the 125-foot contour on the Galena-Platteville isopach map (pl. 23), as the thickness of the Platteville averages between 120 and 150 feet.

*Lithology.*—Brown, gray, buff, and purplish cherty, usually argillaceous dolomite or limestone with thin partings of gray, brown, and purplish brittle fossiliferous calcareous shale makes up the Decorah formation. The distinctive features of the strata as exhibited in well-cuttings are the presence of (1) black, gray, dark brown specks and flakes in the limestone or dolomite, giving it a peculiar speckled appearance, (2) scolecodonts or conodonts, sometimes well preserved but more often fragmentary, (3) shaly surfaces and pits in the cuttings, and (4) speckled, partly sandy gray, brown, and white translucent chert.

In samples from three wells in the eastern part of the region, a semi-oölitic to oölitic, brown to buff, lithographic to very finely granular limestone occurs near and at the top of the formation (app. C, 18, 43). This zone has not been found in wells to the west. The oölites seem to be the result of chemical or biochemical precipitation rather than of mechanical wear, as they consist of concentric rings of calcareous material around a nucleus of silt or very fine sand.

*Thickness.*—In the south and west parts of the Streator quadrangle the Decorah formation is from 40 to 50 feet thick, whereas in the east and south parts of the Marseilles quadrangle it is only 20 to 30 feet thick. A comparison of sample-study logs in the region indicates a progressive thickening to the south and east similar to that found in the Platteville formation.

*Stratigraphic relations.*—The Decorah formation is probably underlain conformably by the Platteville formation throughout the entire region, and in the greater part of the region it is overlain conformably by the Galena limestone or dolomite. However, in the belt where it underlies glacial drift or Pennsylvanian strata, as a result of pre-Pennsylvanian or preglacial erosion or both, it is overlain unconformably by those deposits.

*Correlation.*—The Decorah of north-central Illinois is correlated with the Decorah formation of northern Illinois and of the type section in Iowa on the basis of fossil content (app. G, table 1), lithology, and stratigraphic position. The Decorah formation of Iowa has been correlated[37] with the lower Trenton beds of New York.[38]

### Galena Formation[39]

The Galena formation consists of three members which are, in ascending order, the Prosser, the Stewartville, and the Dubuque, but they cannot be satisfactorily distinguished in well logs, so the formation is herein treated as a single unit.

*Distribution.*—The Galena formation is present in all of the region except the north-central part. Its lower boundary lies between the 150- and 175-foot contour on the Galena-Platteville isopach map (pl. 23).

*Lithology.*—The Galena formation is often referred to as the Galena dolomite, which is erroneous as the formation may be partly or entirely limestone. It is composed of brown to buff, medium to coarsely crystalline partly cherty dolomite or dolomitic limestone. Where it is weathered the formation has a mottled or light yellow color. The dolomite contains numerous vesicles frequently lined with clear crystals of calcite. The limestone contains dispersed crystals of dolomite, mostly less than 0.1 mm. in diameter. Occasionally sand grains are found in the upper half of the formation. The distribution of limestone and dolomite in the Galena formation is related geographically to major structures in the same manner as it was in the Platteville formation (p. 64).

The chert usually occurs in the lower half or third of the formation although it is often present in varying amounts throughout the entire formation. It is white to brown and gray, usually trans-

[37]Kay, G. M., op. cit. pp. 289-290.

[38]Bays, C. A., and Raasch, G. O., Mohawkian relations in Wisconsin: Guidebook of 9th Ann. Field Conference Kansas Geol. Soc., pp. 299-301, 1935.

[39]The Galena formation derives its name from the fact that most of the galena mined from the upper Mississippi Valley was found in it. Foster, J. W., and Whitney, J. D., Geology of the Lake Superior land district, Part II: 32nd Cong. Spec. Sess., Sen. Ex. Doc. 4, p. 146, 1851.

lucent, and frequently contains vesicles lined with clear quartz crystals.

The larger crystal or grain size and the greater porosity of the Galena distinguish it from the underlying Decorah and Platteville formations.

*Thickness.*—Where the Galena formation is overlain by the Maquoketa shale in normal sequence its thickness is between 180 and 200 feet, but where the formation has suffered pre-Pennsylvanian and later erosion and is succeeded by Pennsylvanian or Pleistocene strata (pls. 13, 28, 29), its thickness is highly variable.

*Stratigraphic relations.*—The Galena formation is underlain conformably by the Decorah formation. Its contact with the overlying Maquoketa formation is one of slight disconformity. However, in much of north-central Illinois it is overlain unconformably by Pennsylvanian or Pleistocene beds (pls. 28, 29) as a result of pre-Pennsylvanian or preglacial erosion or both. In the eastern part of the Marseilles quadrangle and near Morris the upper surface of the Galena is deeply channeled as a result of this erosion and has a maximum relief of about 100 feet.

*Correlation.*—The Galena formation of this region is correlated with the Galena formation of northwestern Illinois and Wisconsin on the basis of similarity in lithology, fossil content (app. G, table 1), and stratigraphic position. The Prosser member makes up most of the Galena formation in the Upper Mississippi Valley.[40] The Galena formation of Wisconsin is correlated with the Trenton of New York and the Kimmswick of Missouri.[41]

## CINCINNATIAN SERIES[42]

### Maquoketa Formation[43]

*Distribution.*—The Maquoketa formation is present along the east edge and in the south and the west parts of north-central Illinois. It is absent from all of the quadrangles except the extreme south part of the Streator quadrangle (pls. 13, 25).

*Lithology.*—The Maquoketa formation consists of dolomitic shale and argillaceous dolomite or limestone. Three members are distinguishable,[44] as follows:

| | Thickness Ft. |
|---|---|
| 3. Upper green shale member . . . . | 40-90 |
| 2. Middle limestone or dolomite and shale member . . . . . . . . | 50-120 |
| 1. Lower brown shale member . . . | 25-45 |

The lower member is composed of firm thick-bedded dark brown, occasionally gray or brownish-gray, calcareous or dolomitic shale, locally grading to dark brown very argillaceous limestone. Locally it is very fossiliferous with the majority of the fossils representing bryozoan remains.

The middle member consists dominantly of brown to gray fine- to coarse-grained limestone or dolomite, with some interbedded fossiliferous brownish-gray to drab calcareous or dolomitic shale. The limestone usually has a speckled appearance and contains abundant fragments of bryozoans, crinoids, corals, and brachiopods. The interbedded shale is also quite fossiliferous, the fossils being mostly bryozoan fragments.

The upper member consists of green, greenish-gray, and gray partly silty dolomitic or calcareous shale, with occasional lenses of compact, very finely crystalline, greenish-gray to gray, very argillaceous dolomite or limestone.

*Thickness.*—The Maquoketa formation is usually between 150 and 170 feet thick but 200 feet of it was penetrated in the Ladd village well in eastern Bureau County, and 195 feet in the Rabbit well No. 1 in southeastern Lee County (pl. 28, No. 8).

*Stratigraphic relations.*—The Maquoketa formation is underlain with slight disconformity by the Galena formation.

[40]Bays, C. A., and Raasch, G. O., op. cit. p. 300.

[41]Kay, G. M., op. cit. pp. 290-293.

[42]The Cincinnatian series derives its name from exposures in Ohio and Kentucky in the vicinity of Cincinnati. Meek, F. B., and Worthen, A. H., Acad. Nat. Sci. Philadelphia Proc., vol. 17, p. 155, 1865.

[43]The Maquoketa formation was named for exposures along Little Maquoketa River, Dubuque County, Iowa. White, C. A., Geology of Iowa, vol. 1, p. 181, 1870.

[44]Cady, G. H., Geology and mineral resources of the Hennepin-LaSalle quadrangles: Illinois Geol. Survey Bull. 37, pp. 45-46, 1919.

The contact of the Maquoketa formation with the normally overlying Silurian system is one of erosional unconformity with a probable erosion of as much as 70 feet of the Maquoketa (pl. 25). This amount of erosion is sufficient to remove most or all of the upper shale member of the Maquoketa formation, so that the dolomites of the Silurian may lie directly on the middle dolomite or limestone member of the formation. In such cases the Silurian and Maquoketa dolomites may not be distinguished in drillers' logs, with consequent errors in reported thicknesses of the respective formations.

In parts of the region, however (pls. 13, 28, 29), the Maquoketa formation is succeeded unconformably by Pennsylvanian or Pleistocene strata (pls. 28, 29). In such places the middle dolomite or limestone member may be the highest part of the formation and therefore may be erroneously designated as the Silurian dolomite by drillers.

*Correlation.*—The Maquoketa beds of north-central Illinois are correlated with the Maquoketa formation of Iowa on the basis of stratigraphic position and lithologic characters. The upper part of the Maquoketa formation of Illinois and Iowa has been correlated with the lower Richmond of Indiana and Ohio[46] or considered probably the equivalent of most of the Richmond.[47]

In Iowa the Maquoketa formation is separated into four members, the Elgin, Clermont, Fort Atkinson, and Brainard, in ascending order,[45] but it is not possible to correlate these with the three recognized in north-central Illinois on the basis of available data.

## SILURIAN SYSTEM[48]

The Silurian system in Illinois is composed of rocks of the Alexandrian or Lower Silurian series and Niagaran or Middle Silurian series, which are further divided into formations as shown in table 3. Rocks of Late Silurian or Cayugan age are not definitely known to occur in Illinois.

No Silurian bedrock is known to occur in the Marseilles, Ottawa, and Streator quadrangles, but it is found in wells west of the LaSalle anticline and in northeastern Kendall, in extreme southeastern Grundy, and in Livingston and McLean counties (pls. 13, 27). Strata belonging to the Alexandrian series may occur in the southwest part of the Streator quadrangle.

The thickness of the Silurian system is shown on plate 27.

### ALEXANDRIAN SERIES[49]

The Alexandrian series crops out in northeastern, northwestern, and southwestern Illinois, where it is composed of the Orchard Creek, Girardeau, Edgewood, and Kankakee (Sexton Creek) formations, but as these are very difficult to distinguish in well-cuttings in the region, the series is considered as a unit in the following discussion.

*Lithology.*—The lower part of the Alexandrian series, possibly representing the Edgewood formation, consists of greenish-gray and green, dolomitic or calcareous, sandy siltstone, with some interbedded very finely crystalline silty sandy argillaceous dolomite, and greenish-gray and green dolomitic silty shale. The upper part of the series, possibly representing the Kankakee formation, is composed of

[45]Calvin, Samuel, op. cit. pp. 97-98.

[46]Savage, T. E., Richmond rocks of Iowa and Illinois: Am. Jour. Sci., 5th series, vol. 8, pp. 411-427, 1924.

[47]Ladd, H. S., Stratigraphy and paleontology of the Maquoketa shale of Iowa, Part 1: Iowa Geol. Survey, vol. 34, p. 368, 1929.

Kay, G. M., The Ordovician system in the Upper Mississippi Valley: Guidebook of the 9th Ann. Field Conference, Kansas Geol. Soc., p. 295, 1935.

[48]The name Silurian is derived from Silures, the Roman name for a tribe who formerly inhabited a region that now comprises parts of both England and Wales, where this system of rocks is typically exposed. Murchison, R. I., On the Silurian system of rocks: London and Edinburgh Philos. Mag. and Jour. Sci., 3rd series, vol. 7, pp. 46-52, July 1835.

[49]The name Alexandrian is derived from Alexander County, Illinois. The series was first proposed by Savage to include strata between the top of the Cincinnatian and the base of the Brassfield limestone (Ohio Clinton). Later, when it was shown that the Brassfield was older than the Clinton of New York, Savage modified the definition to include all the strata between the top of the Cincinnatian and the top of the Brassfield.

Savage, T. E., On the Lower Paleozoic stratigraphy of southwestern Illinois: Am. Jour. Sci., 4th series, vol. 25, pp. 433-434, 1908.

Schuchert, Charles, Paleogeography of North America: Geol. Soc. America Bull., vol. 20, p. 538, 1910.

Savage, T. E., Alexandrian series in Missouri and Illinois: Geol. Soc. America Bull., vol. 24, p. 352, 1913.

Table 3.—Provisional Correlation of Silurian Strata in Illinois and Adjacent States

| System | Series | | Illinois | | | Iowa | Missouri | Wisconsin |
|---|---|---|---|---|---|---|---|---|
| | | | Southwestern | Northeastern | Northwestern | | | |
| Silurian | Niagaran | Lockport | | Port Byron | Port Byron | Gower (in part) | Bainbridge | |
| | | | | Racine | Racine | | | Racine (including Guelph) |
| | | | Joliet | Waukesha<br>Joliet | Waukesha<br>Joliet | Hopkinton | | Waukesha |
| | | Clinton | | | | | | |
| | Alexandrian | | Sexton Creek (Brassfield) | Kankakee (Brassfield) | Kankakee (Brassfield) ("Waucoma") | Waucoma | Brassfield | Byron |
| | | | Edgewood<br>Bowling Green<br>Cyrene<br>Noix oölite | Edgewood<br>Bowling Green<br>Essex; Channahon<br>Noix | Edgewood ("Winston") | Edgewood | Edgewood | Mayville |
| | | | Girardeau<br>Orchard Creek | | | | | |

Copied from Savage, T. E., Silurian rocks of Illinois: Geol. Soc. America Bull., vol. 37, pp. 513-534, 1926, with further subdivisions for various parts of Illinois according to same reference.

very finely crystalline buff to gray slightly cherty dolomite or dolomitic limestone.

*Thickness.*—The Alexandrian series appears to be consistently about 50 feet thick in wells where it can be more or less definitely distinguished. However, it is possible that in some of the wells the thickness is greater than this, as some of the beds ascribed to the Niagaran may belong to the Alexandrian series.

*Stratigraphic relations.*—The Alexandrian series is underlain unconformably by the Maquoketa formation. There is little or no break discernible between the Alexandrian and Niagaran series in north-central Illinois, but as the contact is disconformable between the two series elsewhere in the State the two are probably disconformable here.

*Correlation.*—The correlation of the Alexandrian rocks of Illinois with those of adjacent states is shown in table 3.

## NIAGARAN SERIES[50]

The Niagaran series of northern Illinois is divided into the Joliet, Waukesha, Racine, and Port Byron formations (table 3), but as it is difficult to distinguish the formations in well-cuttings, the series is discussed as a unit.

*Distribution.*—The Niagaran series is present only in the west and south part of the region and northeastern Kendall County (pls. 13, 27), and does not occur in the Marseilles, Ottawa, and Streator quadrangles. Limestone or dolomite occurring in the upper part of the Maquoketa formation where the Silurian system is absent (p. 67), especially in a large part of eastern Kendall County, is often erroneously recorded in drillers' logs as

[50]This series derives its name from Niagara Falls where it is well developed. Hall, James, Report of the Survey of the fourth geological district: Natural History of New York, part 4, Geology of New York, vol. 4, p. 80, 1843.

"Niagaran lime" and this fact must be kept in mind in delimiting the extent of the Silurian in this region.

*Lithology.*—Compact to vesicular, finely crystalline light gray, white, and brownish-gray dolomites and dolomitic limestones comprise the Niagaran series. White to light gray dense chert indicative of the Waukesha formation usually occurs in the middle or upper portion of the series. In places the middle portion of the series contains scattered grains of very fine sand.

*Thickness.*—The Niagaran series has a maximum recorded thickness of 550 feet at Minonk.

*Stratigraphic relations.*—The Niagaran series is underlain with slight disconformity by the Alexandrian series. It is overlain unconformably by Pennsylvanian strata except in the vicinity of the village of Henry, Marshall County, where it is succeeded unconformably by the Devonian system.

*Correlation.*—The correlation of the Niagaran formations of northern Illinois is shown in table 3.

## DEVONIAN AND MISSISSIPPIAN SYSTEMS

Devonian strata are present in the western part of the region (pls. 13, 29) and Mississippian strata are certainly known to occur only in the extreme western portion of the region, where 77 feet of brownish-gray micaceous shale of early Mississippian age, containing *Sporangites huronense*, was penetrated in the Henry village well (app. C, 45).

# CHAPTER V—STRATIGRAPHY OF THE EXPOSED FORMATIONS

BY

H. B. Willman

## ORDOVICIAN SYSTEM

### CHAZYAN SERIES

### St. Peter Sandstone[1]

#### DISTRIBUTION OF OUTCROPS

The St. Peter sandstone, the oldest formation exposed in the Marseilles-Ottawa-Streator area, crops out along Illinois Valley west from Fox River to the west side of the Ottawa quadrangle and forms high bluffs along both sides of the valley west of Buffalo Rock. Nearly the entire thickness of the formation is exposed in the cliffs at Starved Rock, where the base of the sandstone is only 10 to 15 feet below low-water level of Illinois River. It is also exposed in the eastern part of the LaSalle quadrangle, west of the Ottawa quadrangle. Along Fox Valley outcrops occur in the valley-walls up as far as the north end of the Marseilles quadrangle and form high bluffs near Wedron at the mouth of Indian Creek. Scattered outcrops are also present along Indian, Buck, and Crooked Leg Creeks in the Ottawa quadrangle and Brumbach and Mission creeks in the Marseilles quadrangle (pls. 1, 2).

#### LITHOLOGY

The St. Peter sandstone is a pure, white or light buff sandstone that is easily distinguished from the other exposed sandstones in the area, which are of Pennsylvanian age, by the presence of rounded and coarser grains, by better sorting, by much less clay and silt, and by the absence of mica. The upper part of the sandstone is medium-grained, the lower part fine-grained. The exceptional purity of the sandstone has made possible the development of a large silica-sand industry near Ottawa, Utica, and Wedron (p. 234).

*Mineralogical Composition*

The sandstone is composed predominately of grains of quartz which locally form 98 per cent or more and rarely as little as 90 per cent of the formation. Next in abundance to quartz is a clay mineral, probably kaolinite. Limonite, pyrite, feldspar, zircon, tourmaline, and a few other minerals are also present.

*Quartz.*—Most of the sand grains are transparent, colorless quartz. The rounded quartz grains appear translucent because their surfaces are frosted but when broken the interior of the grain is found to be transparent and colorless. A few quartz grains are colored by small inclusions of other minerals.

*Kaolinite.*—The sieve analyses (app. D, table 3) show the sand contains from 0.58 to 5.8 per cent grains smaller than about 20 microns in diameter. Samples from the quarries in the Illinois valley-flat at Ottawa usually contain less than 1.5 per cent whereas samples from the quarries in the bluffs between Buffalo Rock and Utica usually contain 2 to 3 per cent of grains of this size. This material includes not only all the clay, which consists of grains mostly smaller than 4 microns, but also some fine silt. The chemical analyses (table 4) suggest that the material smaller than 20 microns consists largely of the clay mineral kaolinite,[2] because of the low potash and soda content and the high loss on ignition, and that it contains about 10 per cent free silica most of which is probably fine silt.

[1]A thorough description of the St. Peter sandstone as exposed in Illinois is given in a report by J. E. Lamar, "Geology and economic resources of the St. Peter sandstone of Illinois," Illinois Geol. Survey Bull. 53, 1928, which should be consulted for further details.

[2]Grim, R. E., personal communication

*Limonite.*—The limonite in the sandstone is a secondary mineral introduced after the deposition of the quartz sand and is the chief coloring material in the sandstone. It colors the sandstone yellow, brown, or red. Although it is present at many places, limonite is actually a relatively minor constituent of the sand, as analyses show that a dark red sand contained only 0.5 per cent iron oxide and a deep yellow sand contained less than 0.3 per cent iron oxide.[3] The average amount of iron oxide in 14 face samples was 0.26 per cent.

*Pyrite.*—Pyrite is locally present and is also secondary in origin. It occurs in small crystals usually along bedding-planes. Locally it is abundant enough to form dark-colored streaks which accentuate the bedding-planes and to cement the sand grains into hard clusters.

Table 4.—Chemical Analyses of Clay Washed from St. Peter Sandstone[a]

| | No. 1 | No. 2 |
|---|---|---|
| $SiO_2$ | 48.88 | 47.42 |
| $Fe_2O_3$ | 2.28 | 2.32 |
| $Al_2O_3$ | 33.43 | 35.01 |
| CaO | 1.56 | 1.26 |
| MgO | 1.06 | 1.18 |
| $K_2O$ | .78 | .94 |
| $Na_2O$ | .04 | .32 |
| $SO_3$ | .34 | .36 |
| Loss on ignition | 13.23 | 13.20 |
| Total | 101.60 | 102.01 |

No. 1—Ottawa Silica Co., Plant C (formerly United States Silica Co.)

No. 2—American Silica Sand Co. (Reynolds west quarry)

[a]Lamar, J. E., op. cit. p. 51.

*Feldspars.*—The feldspars, orthoclase and microcline, have been found both as detrital and secondary grains.[4] The former are rounded and the latter are euhedral. The secondary grains are thought to be detrital grains which have been enlarged by secondary growth. Grains of feldspars are rare in the St. Peter sandstone in the Marseilles-Ottawa-Streator area.

*Other minerals.*—Among the rare constituents of the sandstone are certain minerals whose specific gravities are much higher than that of quartz and which are known as heavy minerals. The amount of heavy minerals in 11 samples varied from 0.002 to 0.07 per cent.[5] The heavy minerals are extremely rare among the larger grains but are common in the sand passing the 200-mesh sieve and retained on the 270-mesh sieve, a grade which is usually less than 1 per cent of the sand. Zircon and tourmaline form by far the greatest part of the heavy minerals. Both vary from almost spherical to slightly worn angular grains. Anatase, spinel, and garnet have also been found.

[3]Lamar, J. E., op. cit., p. 54.

[4]Thiel, G. A., Sedimentary and petrographic analysis of the St. Peter sandstone: Geol. Soc. America Bull., vol. 46, p. 591, 1935.

### *Color*

The St. Peter sandstone is white, yellow, and many shades of brown. The whiteness of the sand is in part due to the frosted surfaces of the grains, although sand which has been secondarily enlarged (so that the frosted surfaces are concealed and the grains are transparent) is nearly as white.

The various shades of yellow and brown are chiefly due to limonite which was introduced by circulating ground waters after the sand was deposited. The yellow sand has a very thin film of limonite scarcely recognizable on the individual grains, but in the more darkly colored sands the limonite forms a conspicuous coating on the grains. The weathered surfaces of natural outcrops of the sandstone are dark grayish-brown, resulting partly from iron oxide and partly from organic matter which is derived from the small plants that grow abundantly on the moist surfaces of the sandstone. Where erosion is comparatively rapid the weathered surface is much lighter in color.

The relative abundance of the yellow or brown sand varies widely. The yellow sand occurs in thin bands to units 20 feet or more thick, the brown sand in bands a fraction of an inch to about a foot thick. The brown or yellow sand is locally interbedded with white sand, and sharp changes in color occur at the bedding-planes. This is locally well shown in cross-bedded sandstone where it is emphasized by the lenticular character of the beds. At some places, however, the contact between brown and white sand is very irregular and bears no relation to stratification. At other places the coloration fades off gradu-

[5]Lamar, J. E., op. cit., p. 60.

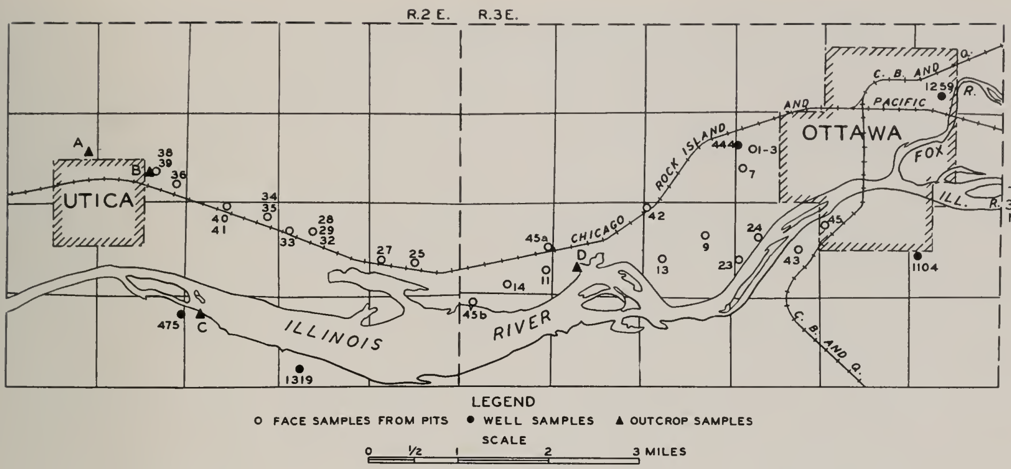


Fig. 32.—Locations where samples of St. Peter sandstone were collected.

ally. Dark reddish-brown or red sand is limited in distribution and usually cuts across bedding planes like veins.

The color of the sand appears to have a general relation to the character of the overburden. Where the sandstone is overlain by Pennsylvanian clay and coal, as along the north bluffs of Illinois Valley from Ottawa to Higbee Ravine and in Buffalo Rock, a large part of the sandstone is yellow, and bands of brown sand are common particularly in the upper part of the formation. Where the sandstone is overlain by glacial drift, it generally contains some yellow sand although less than in the areas where overlain by Pennsylvanian strata, and in some areas, as near Utica and Wedron, the sand is predominately white. The largest areas of white sandstone, with only local areas of yellow sand, are in terraces in Illinois Valley in the vicinity of Ottawa where the stone has a thin overburden of soil or a few feet of limestone.

### *Characteristics of Grains*

*Size.*—The St. Peter sandstone is remarkably uniform in grain size in comparison with most sandstones. Variations are not easily recognized by the eye, but sieve analyses show that the grain size actually varies both laterally and vertically in the formation. A previous study of the St. Peter sandstone in Illinois showed that the upper part of the sandstone was coarser and it was thought to become gradually but not regularly finer toward the middle of the formation.[6] A study of additional samples has shown that the upper part of the formation is medium-grained and the lower part is fine-grained, and that with few exceptions the finest of the medium-grained sand is coarser than the coarsest of the fine-grained sand.

Most of the silica-sand pits in the Ottawa district are located in the upper medium-grained sand, which is coarser grained than the St. Peter in other areas in Illinois[7] and in Missouri,[8] Arkansas,[9] Minnesota, Iowa, and Wisconsin.[10] None of the pits are located entirely in the fine-grained sandstone.

In the previous study most of the analyses were of samples representing the entire pit-face or bench 25 to 75 feet high (app. D, table 3). These data were supplemented in the present study by sieving samples of cuttings from several wells, mostly representing intervals of 5 feet, and samples collected at 5-foot intervals from several outcrops (figs. 32, 33; and app. D, table 4). The samples from the pits were accurately screened, but because the samples from the wells have an

[6]Lamar, J. E., op. cit., p. 44.

[7]Lamar, J. E., op. cit., table 10, p. 148.

[8]Dake, C. L., The problem of the St. Peter sandstone: Univ. of Missouri School of Mines and Metal. Bull., Vol. 6, No. 1, plate VIII, p. 162, 1921.

[9]Giles, A. W., St. Peter and older Ordovician sandstones of northern Arkansas: Arkansas Geol. Survey, Bull. 4, p. 28, 1930.

[10]Thiel, G. A., op. cit., p. 585. The median diameter of the Illinois samples is given as 0.463 mm. It should be approximately 0.350 mm.

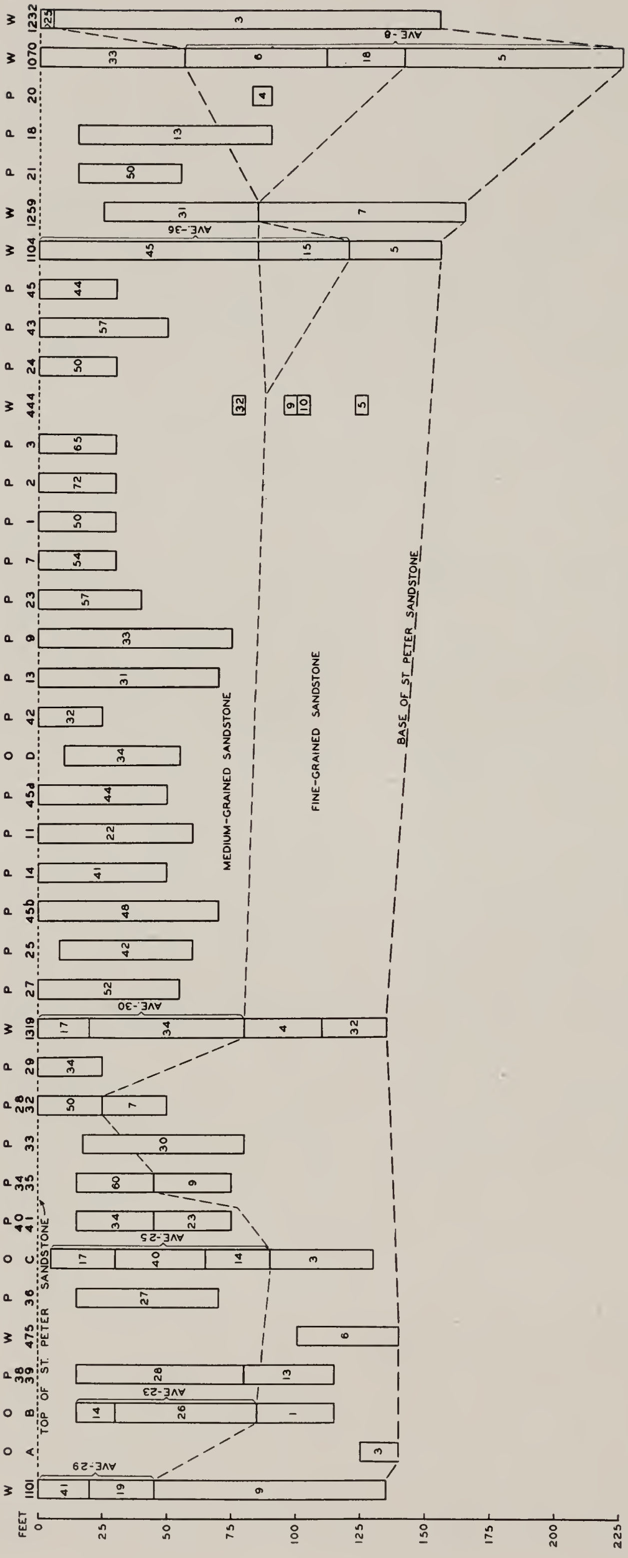


FIG. 33.—Percentage of sand coarser than 35-mesh in St. Peter sandstone. The No. 40 sieve used in the tests of the well and outcrop samples has openings nearly the same as the 35-mesh sieve. The fraction coarser than 35-mesh is largely coarse sand but includes some medium sand. Locations sampled are shown in figure 32.
W—well sample, averages of samples mostly representing 5-foot intervals; analysis in appendix D, table 4.
O—outcrop sample, averages of samples collected at 5-foot intervals; analysis in appendix D, table 4.
P—pit sample, one sample representing entire face, or two samples where noted; analysis in appendix D, table 3.

inherent inaccuracy owing to (1) the possibility that material from higher beds contaminates lower samples, (2) washing out of the fine material, and (3) errors in sampling, and because the outcrop samples were weathered, both the well and outcrop samples were screened only with sieves Nos. 40 and 60 and are accurate within about 2 per cent. The factors affecting the accuracy of the well samples appear to be less important than was expected as their sieve analyses are similar to those of nearby outcrop samples. Caving is of little consequence, as most of the samples of the lower fine-grained sand contain none of the upper coarse grains and in most of the wells the break from the medium-grained to the fine-grained sandstone is sharp. The partial washing out of clay and silt during drilling and in collecting the samples is not important because the formation rarely contains more than 2 or 3 per cent clay and silt. However, experience has shown that sometimes well samples are not carefully collected and this factor may account for variations from the general sequence when shown in only one well.

The medium-grained sandstone comprises the upper one-third to two-thirds of the formation (fig. 33). It is 85-90 feet thick at Utica and Starved Rock but thins sharply eastward and is only 25 to 40 feet thick near the mouth of Higbee Ravine. East of Higbee Ravine to Ottawa it is at least 75 feet and perhaps locally 100 feet thick, but at Wedron and Marseilles it is only 50 to 75 feet thick.

The average of 18 face samples from the pits indicates that the medium-grained sandstone contains about 27 per cent coarse sand, 54 per cent medium sand, 14 per cent fine sand, 2 per cent very fine sand, 0.5 per cent silt, and 2 per cent clay. The median[11] falls in the coarse end of the medium class. The unusual uniformity of the sand is shown by the fact that the amount of medium sand ranged only from 49 to 59 per cent and in 10 of the samples was within 1 per cent of the average amount. Beds as much as 5 feet thick locally contain 50 to 60 per cent coarse sand, and a few thin beds of very fine-grained sandstone, called "magnesia" beds, contain little or no coarse sand. The largest grains observed were about 1¾ mm. in diameter.

In general the medium-grained sandstone appears to be coarsest at Ottawa, somewhat finer near Buffalo Rock, nearly as coarse near Higbee Ravine as at Ottawa, and somewhat finer again near Utica.

The contact of the medium-grained sand with the underlying fine-grained sand is sharp although difficult to locate in outcrops because of the similar appearance of the two sands. However, at the few places where it was observed the contact is a bedding-plane little if any more distinct than the other bedding-planes. Only three face samples represent the fine-grained sandstone. These averaged 5 per cent coarse sand, 48 per cent medium sand, 33 per cent fine sand, 10 per cent very fine sand, 2 per cent silt, and 2 per cent clay, which shows that the fine-grained sandstone has nearly as much medium sand as the overlying medium-grained sand but differs in the smaller amount of coarse sand and the larger amount of fine and very fine sand. The median falls at the fine end of the medium sand in two of the three face samples, but in the well and outcrop samples it usually falls in the fine sand.

The difference between the medium-grained and the fine-grained sand is further shown by a comparison of the amounts retained on the 35-mesh and No. 40 sieves, the only sieves with comparable openings in all the tests (fig. 33). Nearly all the samples from the medium-grained sand contain more than 25 per cent of grains coarser than the 35-mesh sieve, with a maximum of 72 per cent, whereas nearly all of the fine-grained sand contains less than 10 per cent.

Although the differentiation of the St. Peter sandstone into two units is distinct in the Ottawa district, it is uncertain how far this differentiation extends. West of the area it is recognizable in a well at Peru (fig. 33, sample 1101), but southeast of the area at Ransom, where the formation has about the same thickness as at Ottawa, only the upper 5 feet of the sandstone is medium-grained, and it is possible that the upper part of the sand grades laterally to fine-grained sand. However, the St.

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[11]The median size is the diameter of the openings in a sieve which would divide the sample by weight into two equal parts, in other words, the average grain size by weight.

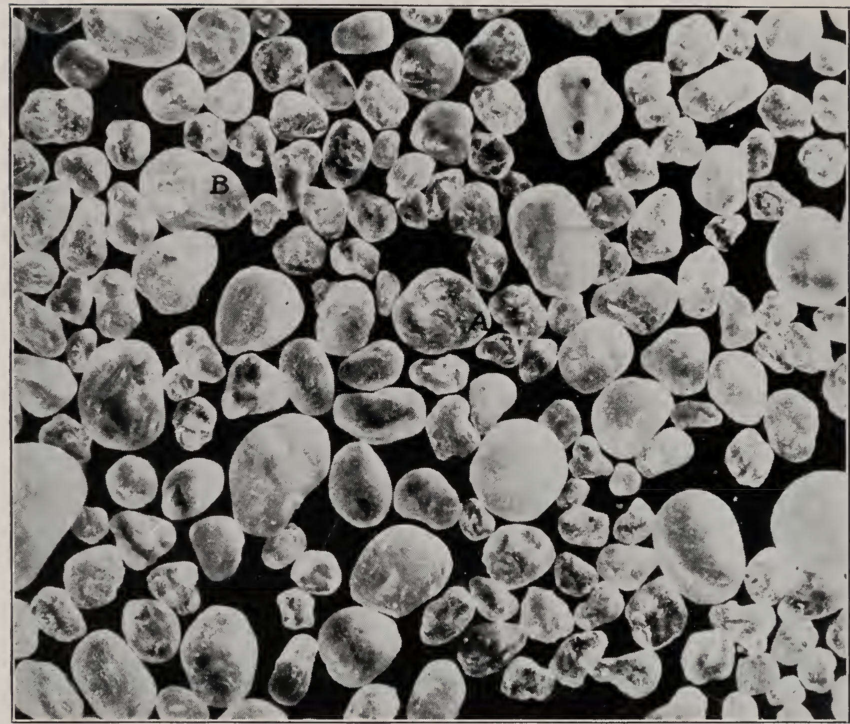



Fig. 34.—St. Peter sand showing the character of the surface and the shapes of the grains. Magnified about 20 times. (Illinois State Geological Survey Bull. 53, p. 46.)

Peter sandstone is generally thicker south of the Ottawa district, and a strong unconformity on top of the sandstone suggests that a large part of the medium-grained sandstone may have been eroded.

*Sorting.*—The St. Peter sand is strikingly well and uniformly sorted. The sieve analyses show that the amount of material near the extremes of size is low and that, with few exceptions, 80 per cent or more of the sand is composed of grains of which the largest have diameters only 2 to 3 times as large as the smallest grains. Within this range of grain size the sandstone is a uniformly heterogeneous mass with the smaller grains filling the spaces between the larger.

More than 50 per cent of the sand passes the 28-mesh and is retained on the 48-mesh sieve in 28 of 32 face samples, and 22 of these samples contained more than 60 per cent with a maximum of 80 per cent of this size. The uniformity of the sand is also emphasized by the fact that in all 32 face samples either the 35- or 48-mesh sieve retained the largest amount of sand. In many of the analyses 40 to 50 per cent of the sand was retained on one of these sieves. In comparison with other natural sands this uniformity is high.[12]

*Shape.*—The relative abundance of well-rounded grains in the St. Peter sandstone decreases greatly with decreasing size. All of the sand coarser than 48-mesh, which includes 50 to 80 per cent of the sand, is well-rounded. The sand passing the 48-mesh sieve and retained on the 100-mesh sieve is subangular, and that passing the 100-mesh sieve is angular. However, a few rounded grains occur even in the sand retained on the 270-mesh sieve. Although angular sand predominates only in the grades finer than 100-mesh, distinctly angular grains are present as large as 48-mesh.

Some of the well-rounded grains are almost spherical in shape but most of them are irregular with well-rounded corners (fig. 34). Shallow pits on the surfaces of most of the grains detract from the regu-

[12]Thiel, G. A., op. cit., p. 582.

larity of their shapes. Most of the angular sand is composed of roughly equidimensional grains, and lath-shaped or flaky grains are not common.

Some of the originally well-rounded sand grains have become angular by the addition of secondary quartz which has developed angular crystal faces. As the secondary quartz is clear and the crystal faces are smooth and flat, it usually may be differentiated from the unaffected surfaces which are frosted.

*Frosting.*—The surfaces of the grains larger than 48-mesh are covered with minute depressions and look like frosted glass. A microscopic examination shows that the frosting is much less uniform than appears to the eye, and although a few of the grains are so densely frosted as to appear opaque most of them are translucent. The more nearly spherical grains are usually more frosted. The smaller grains are less frosted than the larger, although some frosting occurs on the smallest sand grains.

*Pitting.*—The surfaces of nearly all the sand grains also contain pits, which are depressions much larger than those forming the frosting. Nearly all the grains coarser than 48-mesh have one or more pits. Although more conspicuous on the larger grains, they also occur on many of the small grains. The pits are of all sizes and shapes; some penetrate half the thickness of the grains and are nearly as broad as the grain; some are deep and conical; others are broad, shallow, and flat-bottomed. The surfaces of many of the broader pits are frosted, but the deep, narrow pits are frosted only at their mouths.

Most of the pits are probably as old as the quartz grains themselves. The quartz grains originated in igneous rocks, in which they were surrounded and penetrated by other minerals and so had very irregular surfaces. The other minerals were less resistant to weathering, so that when the parent rocks weathered they disappeared leaving the quartz grains with their irregular pitted surfaces. The grains have since been rounded, and only remnants of the original depressions remain. However, some of the pits have probably resulted from the enlargement of the grains by the deposition of secondary silica, the depressions being formed at the contact with other grains where the silica was not deposited.

*Secondary enlargement.*—The surfaces of some sand grains are partly covered by a thin layer of glassy quartz with angular crystal faces. This quartz was deposited in the same crystallographic orientation as that in the original sand grains, by water circulating through the sandstone. In the outer few inches of sand at many outcrops almost every grain is largely bounded by the crystal-faces of secondary silica, concealing the original rounded and frosted surfaces.

### *Cementation*

The fresh sandstone is friable and crumbles easily. What solidity the fresh sandstone possesses appears to be largely the result of compaction by the weight of the overlying strata. The sandstone generally contains little cementing material. The iron oxide that is present acts partly as a cement but forms such a weak bond that distinctly yellow sand is but slightly firmer than white. However, in some thin dark brown or red vein-like streaks the interstitial spaces are largely filled with iron oxide and the sandstone is cemented firmly enough to form resistant ridges on weathered surfaces. The amount of secondary silica is also so small that it does not add appreciably to the bond of the sand.

The weathered surface of the sandstone is usually more solid than freshly exposed stone. This results from the deposition of quartz, limonite, and probably minor quantities of other substances by groundwater evaporating as it reaches the surface, and has been called "case-hardening." The case-hardening varies from an inch or two to as much as a foot thick. The quartz so deposited enlarges the sand grains appreciably but little of it is an effective cement. Some of the case-hardened sandstone in which practically every grain has been covered with silica pulverizes easily between the fingers, and is hard only by comparison with the fresh stone.

Case-hardening is thought to give the sandstone sufficient strength to remain in vertical cliffs (figs. 17-20) such as those at Starved Rock. Although this is no doubt an important factor, the fresh sandstone

Fig. 35.—Top of clay pocket at pit of Ottawa Silica Company, SE. ¼ SE. ¼ NW. ¼ sec. 10, T. 33 N., R. 3 E. (Ottawa Twp.), Ottawa quadrangle. This place has been worked out.

has sufficient solidity to retain vertical faces in some of the sand pits which have not been used for many years and where no case-hardening is recognizable.

### CLAY POCKETS

Large pockets of clay are exposed in the St. Peter sandstone in the pits along the north bluffs of Illinois Valley near Buffalo Rock, in the pits of the Ottawa Silica Company (fig. 35), the Wedron Silica Company, and elsewhere. The pockets are roughly cylindrical in shape with a diameter of 5 to 60 feet and they usually taper toward the base (fig. 36). They extend from the top of the formation to different depths. Some are only 10 feet deep but many are 25 to 30 feet deep. The deepest known is about 100 feet deep and some may extend entirely through the formation. Locally several of the clay pockets occur in a line along one of the major joints in the sandstone.

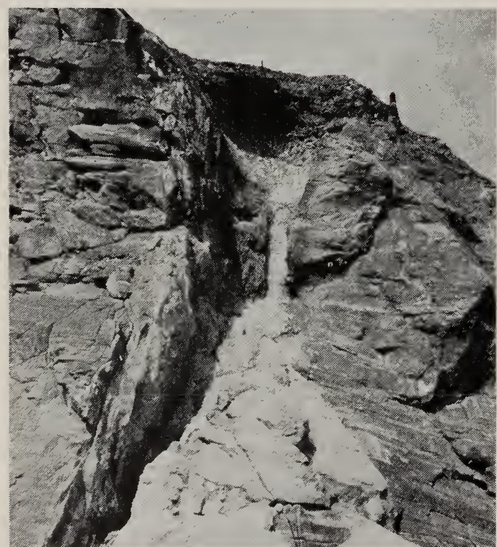


Fig. 36.—Small clay pocket at west end of Buffalo Rock, NE. ¼ NW. ¼ NW. ¼ sec. 19, T. 33 N., R. 3 E. (Ottawa Twp.), Ottawa quadrangle.

The clay in the pockets is soft, plastic, light gray in color and similar in appearance to the clay which forms the basal bed of the Pennsylvanian strata overlying the sandstone. The clay is usually not sandy except at the contact with the sandstone. In the upper part of some pockets there is coal, locally as much as 2 feet thick. The coal is similar in appearance to the LaSalle (No. 2) coal and has thin clay partings. It is considerably deformed along the sides of the pocket and the beds are locally almost perpendicular. The coal is locally 15 to 20 feet below the top of the sandstone.

### CHEMICAL COMPOSITION

The St. Peter sandstone commonly contains more than 97 per cent silica. The commercial washed sand contains more than 99 per cent silica and some of the purest sand when washed contains 99.9 per cent silica (chemical analyses in app. H, table 1). The very high content of silica not only indicates the scarcity of minerals other than quartz but also shows the quartz grains themselves are remarkably free from inclusions. The sand generally contains less than 0.35 per cent iron oxide, even in the yellow sand. Much of the iron oxide present is in the clay fraction, and when the clay is washed out the sand contains less than 0.05 per cent iron oxide. Even less than 0.02 per cent iron oxide is present in some of the especially pure sand. The magnesia, lime, and alumina reported in analyses of the washed sand are probably present in a small amount of clay not removed in the washing process, or in inclusions in the quartz grains.

### STRUCTURAL FEATURES

*Bedding.*—The sandstone is generally well bedded (fig. 37) in beds exceedingly variable in thickness. The beds are generally more than one foot thick although thin beds are not uncommon, especially in the upper part of the formation, and in places they are 10 to 12 feet thick. The individual beds are usually continuous and fairly even, although occasionally there are lenticular beds and others that gradually thin out and disappear. The bedding-planes are gently wavy and persistent. They are marked locally by thin streaks of finer grained sand or silt. The sandstone weathers more easily at the bedding-planes and deep reentrants form along them in cliffs long exposed to weathering (figs. 9, 18).

*Cross-bedding.*—Cross-bedding (fig. 37) occurs at many localities but rarely occurs throughout any considerable thickness of sandstone. It appears to be of the water-laid type, and the inclination of the beds is rarely more than 20 degrees. It is well exposed in the pits of the Ottawa Silica Company, Plant C, and the Wedron Silica Company.

*Joints.*—The sandstone is fractured by large joints which are mostly in two systems nearly at right angles (p. 188). Most of the joints are essentially vertical although some are inclined as much as 30 degrees (fig. 20). The joints generally extend through a considerable thickness of sandstone. Some of the joints at Starved Rock are continuous from the top to the bottom of the rock, about 125 feet, and they probably extend completely through the formation. At several places there is a fractured zone consisting of two parallel joints 1 to 5 feet apart, between which the sandstone is fractured by many smaller joints. In such places the bedding is commonly offset within the fractured zones but there is usually no differential movement along the main joints.

Fig. 37.—St. Peter sandstone in pit of Ottawa Silica Company, SW. ¼ NW. ¼ sec. 10, T. 33 N., R. 3 E. (Ottawa Twp.), Ottawa quadrangle.

*Mud cracks.*—Dessication or mud cracks locally occur in some of the upper beds of the sandstone, especially in a quarry near Utica in the SW. ¼ SW. ¼ sec. 10, T. 33 N., R. 2 E. (Utica Twp.), Ottawa quadrangle.

*Ripple marks.*—Ripple marks are present but are rare.

### FOSSILS

The only fossils found in the St. Peter sandstone in the Ottawa area are worm borings,[13] which have been identified as *Scolithus minnesotensis* Hall.[14] They are tubular borings ⅛ to ¼ inch in diameter filled with sand which is coarser grained

[13] Lamar, J. E., op. cit. p. 36.

[14] Knappen, R. S., The geology and mineral resources of the Dixon quadrangle: Illinois Geol. Survey Bull. 49, p. 51, 1926.

than that surrounding the borings. They have been noted in the pit of the Ottawa Silica Company, Plant C, and the American Silica Sand Company pit in the SE. ¼ SE. ¼ NE. ¼ sec. 18, T. 33 N., R. 3 E. (Ottawa Twp.), Ottawa quadrangle where they occur in fine-grained well-cemented beds. A number of marine fossils have been described from the St. Peter sandstone in Minnesota.[15]

## MOHAWKIAN SERIES

### Platteville Limestone

#### DISTRIBUTION OF OUTCROPS

The Platteville limestone crops out in the Ottawa quadrangle (pl. 2) near Ottawa and Starved Rock, where remnants of the formation occur in channels in the top of the St. Peter sandstone. The limestone is well exposed one mile southwest of Ottawa, where it is the overburden at the sand pits of the Standard Silica Company, Plant No. 2, in the SW. ¼ SE. ¼ NE. ¼ sec. 16, and of the Aetna Sand and Gravel Company, NW. ¼ SE. ¼ sec. 16, T. 33 N., R. 3 E. (Ottawa Twp.). It is also exposed along the lower part of Covel Creek in the SW. ¼ NE. ¼ SE. ¼ sec. 21, T. 33 N., R. 3 E. (South Ottawa Twp.), and in Starved Rock State Park at the heads of French Canyon and Pontiac Canyon, NW. ¼ NW. ¼ SW. ¼ sec. 22, and Sac Canyon in the SE. ¼ SW. ¼ NE. ¼ sec. 21, T. 33 N., R. 2 E. (Deer Park Twp.). All these outcrops have been correlated with the Mifflin member of the Platteville formation (p. 63).

An outcrop of "Trenton" limestone, the name formerly used for the Platteville limestone, is reported[16] to occur southeast of Serena in the bed of Fox River a few rods above the north line of sec. 31, T. 35 N., R. 5 E. (Serena Twp.), Marseilles quadrangle, occupying a depression in the St. Peter sandstone, but it could not be located in the present study. This reported outcrop is well below the middle of the St. Peter sandstone which crops out nearby, and so, if a limestone does exist at this locality, it is more likely to be the underlying Shakopee formation, which crops out along the river only about three miles upstream.

[15]Sardeson, F. W., Fossils in the St. Peter: Minnesota Soc. Nat. Sci. Bull., vol. 4, pp. 64-87, 1896.

[16]Freeman, H. C., LaSalle County: Geological Survey of Illinois, vol. 3, p. 278, 1868.

#### THICKNESS

About 15 feet of the Platteville limestone is exposed along Covel Creek and in the outcrops near the west side of Ottawa. In both of these localities the maximum thickness of the limestone is about 20 feet. In much of the area west of Ottawa the limestone is thin, frequently only about one foot thick, and consists of more or less discontinuous boulder-like slabs. The maximum thickness of the limestone in the outcrops in Starved Rock State Park is about 10 feet.

#### LITHOLOGY

The Platteville limestone as exposed in the outcrops near Ottawa and Starved Rock is a dense fine- to medium-grained dolomitic limestone.

*Color.*—The limestone is light gray on fresh surfaces but where weathered is usually mottled light buff, light gray, and nearly white (fig. 38-A). In some places the light gray stone predominates; elsewhere the stone is largely light buff; the nearly white stone usually forms less than 10 per cent of the formation. The boundaries between the different colored units appear sharp but when observed highly magnified under a microscope they are seen to be gradational. The mottled areas are irregular in shape and size and have curved outlines.

*Mineralogical composition.*—The Platteville formation is a mixture of calcite and dolomite with a small amount of clay and locally a little chert. A chemical analysis of the rock exposed along Covel Creek (app. H, table 1) shows it contains about 57 per cent calcite, 38 per cent dolomite, and 5 per cent siliceous material, mostly clay.

The mineralogical variations of the rock are much more conspicuous on the weathered surfaces than on the fresh (fig. 38-A) and may be better emphasized by etching a smoothed surface with a dilute solution of hydrochloric acid (fig. 38-B). A few grains of potassium ferricyanide added to the acid will color the dolomite blue.

The rock that appears nearly white on the weathered surface is composed largely of very finely crystalline calcite with a few perfect rhombohedrons of dolomite much larger than the calcite grains.

The light gray stone is similar to the nearly white but the calcite grains in the groundmass are larger, about 0.01 mm. in diameter, and the dolomite crystals are more abundant. The limestone grains are irregular in shape and are without definite crystal outlines. The dolomite crystals vary in size but are mostly larger than the limestone grains and some are about 0.25 mm. in diameter.

The light buff stone consists of finely crystalline dolomite in irregular grains coarser (0.05 mm. in size) than the groundmass in the other two types. Acid reactions and differential solubility indicate that a small amount of finely divided calcite is present. There are no large dolomite crystals such as are found in the other rock types.

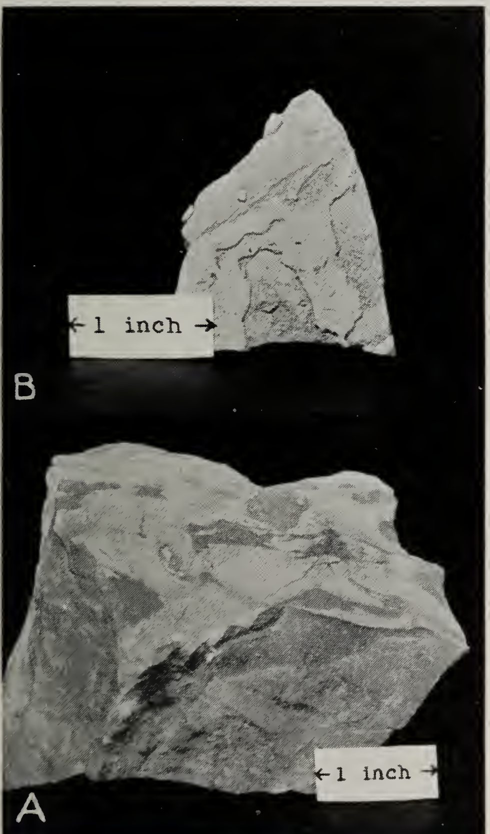


Fig. 38.—Mottled Platteville limestone showing (A) a specimen with light and dark mottled areas on the weathered surface (above) and inconspicuous mottling on the fresh surface (sides), and (B) a specimen with the mottling accentuated by etching with hydrochloric acid.

Fig. 39.—Caverns in the base of the Platteville limestone filled with Pennsylvanian clay, pit of Aetna Sand and Gravel Company, NW. ¼ SE. ¼ sec. 16, T. 33 N., R. 3 E. (Ottawa Twp.), Ottawa quadrangle. The hammer head rests on the top of the St. Peter sandstone.

A small amount of light gray or tan chert locally occurs in small irregularly-shaped nodules distributed along bedding-planes or along definite horizons in the beds. Rounded grains of sand similar to the grains of St. Peter sandstone are common in the lower part of the formation.

*Bedding.*—The beds are usually less than 1 foot thick but are not regular in thickness. Beds 2 to 3 inches thick are common in the lower 5 feet of the formation (fig. 39).

### CHEMICAL COMPOSITION

A sample (W-80) of the limestone exposed along Covel Creek contained approximately 95.5 per cent carbonates of which 78.0 per cent was calcium carbonate and 17.5 per cent was magnesium carbonate (app. H, table 1).

### CLAY POCKETS

The limestone locally contains clay-filled joints and pockets of clay which are exposed in the pit of the Aetna Sand and Gravel Co., southwest of Ottawa (fig. 39). Many of the clay pockets are along the contact between the limestone and the St.

Peter sandstone. The pockets are variable in shape and size; the largest observed was about 5 feet high and slightly greater in width. The clay is light to dark gray, contains thin coal-streaks, and resembles the basal Pennsylvanian clay.

#### FOSSILS

Fossils are common in the Platteville limestone but most of them are poorly preserved (app. G, table 1, and pl. 30).

### Decorah Formation

#### DISTRIBUTION OF OUTCROPS

About 12 feet of the Decorah formation crops out in the southwest corner of the Ottawa quadrangle in the valley-floor of Vermilion River in the SE. ¼ sec. 9, T. 32 N., R. 2 E. (Deer Park Twp.), and in the northwest corner of the Streator quadrangle along the lower part of the ravine in the NE. ¼ NE. ¼ NE. ¼ sec. 16, T. 32 N., R. 2 E. (Deer Park Twp.) (pls. 2, 3). Better outcrops occur along the river in the LaSalle quadrangle for about a mile downstream from the edge of the Ottawa quadrangle, especially in the vicinity of the highway bridge at Lowell.

#### STRATIGRAPHIC POSITION

The Decorah beds in the outcrops in the Ottawa and Streator quadrangles are nearly horizontal and are almost continuous with those at the Lowell bridge, which recent studies[17] have indicated are probably at or near the base of the formation, and may include both Ion and Guttenberg members. Because of the westerly dip of the strata west of the bridge, about 35 feet of the Decorah formation and about 115 feet of the overlying Galena formation are exposed.

#### LITHOLOGY

The formation varies from limestone to dolomite but much of it is a dolomitic limestone. Most of the beds are finely crystalline, but coarse-grained crinoidal

Fig. 40.—Mottled surface of Decorah limestone along Vermilion River at Lowell, NE. ¼ SE. ¼ sec. 8, T. 32 N., R. 2 E. (Vermilion Twp.), LaSalle quadrangle.

beds are present. The rock is light gray on fresh surfaces but most of it weathers buff with a mottled appearance (fig. 40). It is similar in general appearance and mineralogical character to the Platteville limestone (p. 80). Chert nodules are present but are not abundant.

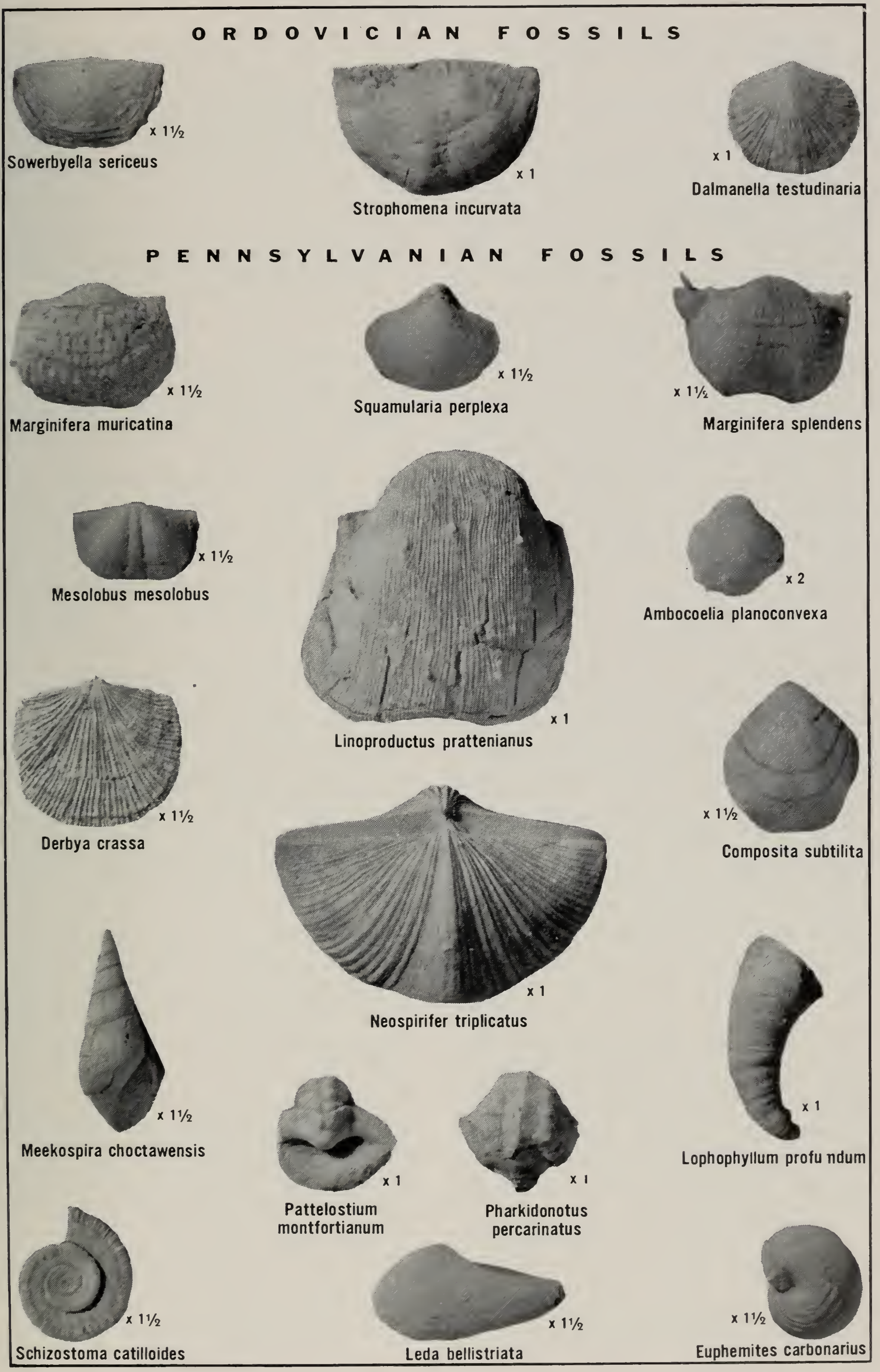
The beds are irregular in thickness although usually less than 1 foot thick. Near the bridge at Lowell the beds are locally 5 to 6 feet thick and one bed about 10 feet thick weathers as a single unit although it reveals a number of faint bedding-planes. The bedding-planes are distinctly wavy and although most of them are persistent, some are discontinuous.

The Decorah is similar in appearance to the overlying Galena formation and is differentiated on the basis of fossils.

#### FOSSILS

Some of the Decorah beds are very fossiliferous, with crinoid stems abundant, but much of the formation is sparingly fossiliferous and the fossils are poorly preserved (app. G, table 1, and pl. 30).

[17] Templeton, J. S., Illinois Geol. Survey manuscript.


ORDOVICIAN FOSSILS
x 1½
Sowerbyella sericeus
x 1
Strophomena incurvata
x 1
Dalmanella testudinaria
PENNSYLVANIAN FOSSILS
x 1½
Marginifera muricatina
x 1½
Squamularia perplexa
x 1½
Marginifera splendens
x 1½
Mesolobus mesolobus
x 1
Linoproductus prattenianus
x 2
Ambocoelia planoconvexa
x 1½
Derbya crassa
x 1½
Composita subtilita
x 1
Neospirifer triplicatus
x 1½
Meekospira choctawensis
x 1
Pattelostium montfortianum
x 1
Pharkidonotus percarinatus
x 1
Lophophyllum profu ndum
x 1½
Schizostoma catilloides
x 1½
Leda bellistriata
x 1½
Euphemites carbonarius

# PENNSYLVANIAN SYSTEM[18]

## INTRODUCTION

Strata of Pennsylvanian age, commonly known as "Coal Measures," are the youngest bedrock strata in the Marseilles-Ottawa-Streator area and are either exposed (pls. 1-3) or directly underlie unconsolidated surficial deposits in four-fifths of the area (pl. 11). The area is along the north boundary of the Eastern Interior coal basin. In order of abundance the strata consist of shale, sandstone, clay, coal, limestone, siltstone, and many intergradational types. The shales and sandstones comprise more than 90 per cent of the strata. Some of the beds have furnished raw materials for large mineral industries—five of the coals, two of the clays, and two of the shales have been mined.

### Thickness

The thickness of the Pennsylvanian system in the area increases irregularly from its boundary to a maximum thickness of about 450 feet in the southwest corner of the Streator quadrangle, on the west slope of the LaSalle anticline. The maximum thickness of exposed strata is about 300 feet. The variations in thickness are due to the irregular upper surface which results from the erosion of the present as well as preglacial valleys and to variations in the elevation of the base of the Pennsylvanian system. The approximate thickness of the Pennsylvanian strata at any place in the area may be computed by adding to the thickness of the beds below LaSalle (No. 2) coal (fig. 44) the thickness of the beds above the coal, which may be obtained by determining the difference between the elevation of coal No. 2 (pl. 12) and the elevation of the bedrock surface (pls. 4-6).

Most of the individual lithologic units of the system are lenticular and some beds

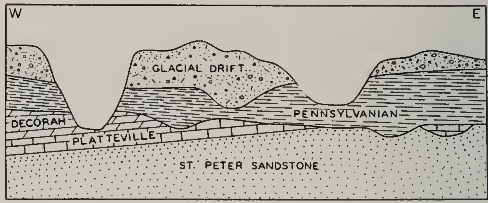



Fig. 41.—Diagrammatic sketch showing the unconformable relations of the Pennsylvanian system to Ordovician strata and Pleistocene deposits in the Marseilles-Ottawa-Streator area.

vary as much as 1 to 3 feet in thickness in a horizontal distance of 25 feet. Commonly one bed thickens at the expense of another so that the total thickness of the strata remains fairly uniform with only slight regional variations. Although the maximum thickness of the exposed Pennsylvanian strata in the area is only about 300 feet in any one place, the total of the maximum thicknesses of the individual units is more than 500 feet.

### Stratigraphic Relations

In the Marseilles-Ottawa-Streator area the exposed Pennsylvanian beds rest unconformably on the St. Peter, Platteville, and Decorah formations of the Ordovician system (fig. 41), in the surface of which shallow channels had been eroded in pre-Pennsylvanian or early Pennsylvanian time.

At most outcrops in the area the Pennsylvanian and Ordovician beds appear to be parallel, but they actually diverge slightly, the Pennsylvanian beds dipping a little less than and truncating the Ordovician beds.

Records of wells (pl. 29) west of the Ottawa quadrangle show that on the west slope of the LaSalle anticline the Pennsylvanian strata successively overlap Ordovician and Silurian formations which had been previously folded and truncated by erosion, and it is assumed that the same situation occurs along the west slope of the LaSalle anticline in the southwest corner of the Streator quadrangle. This

[18]Named for the state of Pennsylvania. Williams, H. S., The geology of Washington County: Arkansas Geol. Survey, Ann. Rept. for 1888, vol. 4, p. xiii, 1891.

angular relationship is observable along Vermilion River at Lowell, a short distance west of the Ottawa quadrangle, in the southeast corner of the LaSalle quadrangle, where exposed beds of the Decorah and Galena formations dip westward 5 to 10 degrees whereas the LaSalle (No. 2) coal, near the base of the overlying Pennsylvanian strata, dips less than 1 degree.

The Pennsylvanian system is overlain unconformably by unconsolidated deposits of the Pleistocene system. Except for thin local patches of conglomerate, possibly Tertiary in age, there are no strata representing the several intervening systems which in western United States and elsewhere total many thousands of feet.

## Development in Illinois

Early studies of the Pennsylvanian strata consisted chiefly of attempts to correlate individual beds of importance, such as the coals and limestones, throughout the Illinois coal basin. The coals were commonly called by the name of some town in the area where they were mined and so a great many names were frequently applied to the same coal, as for example, the Morris, Wilmington, LaSalle, and Colchester coals are all the same bed. The first detailed studies of the "Coal Measures" or "Upper Carboniferous" strata were made by Worthen and assistants[19] about 75 years ago. In this early work an attempt was made to build up a generalized section for the State, and for convenience in classification the coals of commercial importance were numbered, No. 1 being applied to the lowest commercially important coal. The "Coal Measures" were then grouped into two units, Upper and Lower, with the Shoal Creek limestone as the line of separation.[20]

Many years later, studies of the fossil plants[21] associated with the coals resulted in a general correlation of the Illinois "Coal Measures" with those of the Appalachian region. The strata below coal No. 2 were correlated with the Pottsville, the strata between the base of coal No. 2 and the top of coal No. 6 with the Allegheny, and the higher strata with the Conemaugh formations. The name "Pottsville" was retained for the lowest group of strata in Illinois but the names "Carbondale"[22] and "McLeansboro"[23] were adopted for the beds approximately equivalent to the Allegheny and the Conemaugh respectively. Recent studies[24] have indicated that the beds called Pottsville in Illinois may not be correlative with the Pottsville in Pennsylvania, and so the names Tradewater and Caseyville, which have been used in Kentucky for some time, are being adopted instead. Until recently these units have been treated as formations, but because they are considered to be of higher rank, the practice of designating them as groups has been adopted.[25]

In a study of the "Coal Measures" in the Peoria quadrangle an orderly repetition of a certain sequence of various kinds of strata was recognized.[26] The strata were grouped into cycles of deposition with the base of the coals as the point of separation of the cycles. Later the wide distribution of unconformities at the base of some of the sandstones was recognized, and because of the extent of the unconformity at the base of the Bernadotte sandstone the separation of the Carbondale and Pottsville along that line was proposed.[27]

Later the cyclical character of the strata was re-emphasized,[28] the base of the sandstones was adopted as the basis of separation of the cycles, and the deposits of each cycle were considered formational units, for which, because of their difference from the units called formations in other systems, the term "cyclothem" was later proposed [29]

[19]Worthen, A. H., Geological Survey of Illinois, volumes 1-8, 1866-1890.

[20]Worthen, A. H., Geological Survey of Illinois, vol. 6, p. 1, 1875.

[21]White, David, Report of the field work in the coal districts of the State: Illinois Geol. Survey Bull. 4, pp. 201-203, 1907.

[22]Shaw, E. W., and Savage, T. E., U. S. Geol. Survey Geol. Atlas, Murphysboro-Herrin folio (No. 185), p. 6, 1912.

[23]De Wolf, F. W., Studies of Illinois coal (Introduction): Illinois Geol. Survey Bull. 16, p. 181, 1909.

[24]Wanless, H. R., Chapter on Pennsylvanian stratigraphy in: White, David, "Flora of the lower Pennsylvanian in Illinois": U. S. Geol. Survey, unpublished manuscript.

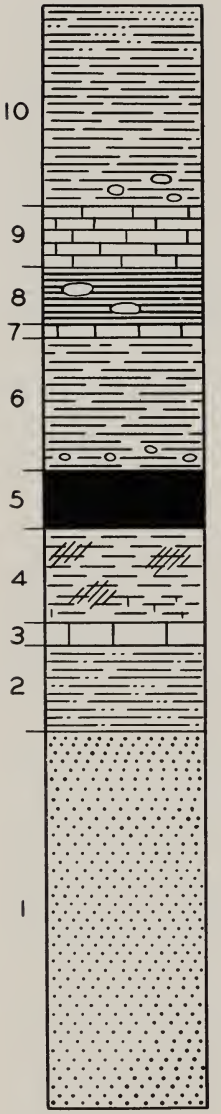
[25]Weller, J. M., Geology and oil possibilities of extreme southern Illinois: Illinois Geol. Survey Rept. Inv. 71, 1941.

[26]Udden, J. A., Geology and mineral resources of the Peoria quardangle: U. S. Geol. Survey Bull. 506, pp. 27, 47-50, 1912.

[27]Savage, T. E., Significant breaks and overlaps in the Pennsylvanian rocks of Illinois: Am. Jour. Sci., vol. 14 pp, 307-316, 1927.

[28]Weller, J. Marvin, Cyclical sedimentation of the Pennsylvanian period and its significance: Jour. Geology vol. 38, pp. 97-135, 1930.

[29]Wanless, H. R., and Weller, J. Marvin, Correlation and extent of Pennsylvanian cyclothems: Geol. Soc. America Bull., vol. 43, p. 1003, 1932.




Shale, gray, sandy at top; contains marine fossils and ironstone concretions especially in lower part.

Limestone; contains marine fossils.

Shale, black, hard, laminated; contains large spheroidal concretions ("Niggerheads") and marine fossils.

Limestone; contains marine fossils.

Shale, gray; pyritic nodules and ironstone concretions common at base; plant fossils locally common at base; marine fossils rare.

Coal; locally contains clay or shale partings.

Underclay, mostly medium to light gray except dark gray at top; upper part noncalcareous, lower part calcareous.

Limestone, argillaceous; occurs in nodules or discontinuous beds; usually nonfossiliferous.

Shale, gray, sandy.

Sandstone, fine-grained, micaceous, and siltstone, argillaceous; variable from massive to thin-bedded; usually with an uneven lower surface.

Fig. 42.—An ideally complete cyclothem.

In view of the fact that the coals Nos. 2 and 6, which have been used as reference horizons for the breaks between the Pottsville, Carbondale, and McLeansboro groups, fall within cyclothems as now defined, it has been decided that for consistency the breaks between the groups should be made at the base of the cyclothems. Consequently the break between the Tradewater and the Carbondale groups is now placed at the base of the Lower Liverpool cyclothem, below coal No. 2, and the break between the Carbondale and McLeansboro groups is placed at the base of the Sparland cyclothem which is the cyclothem next above the one that contains coal No. 6.[30]

## General Character of the Cyclothems

If the different kinds of beds that have been observed in the cyclothems at various places in the Marseilles-Ottawa-Streator area occurred regularly in all the cyclothems, each cyclothem would consist of the following sequence of lithologic units, from base upwards: (1) sandstone or siltstone, (2) sandy shale, (3) limestone, (4) underclay, (5) coal, (6) gray shale, (7) limestone, (8) black shale, (9) limestone, and (10) gray shale (fig. 42). This complete sequence rarely occurs. Units conspicuous in a cyclothem at some places are absent elsewhere. In many cyclothems one or more of the units have not been found, and although many of them may be found somewhere as detailed studies are extended, it is also probable that in some cyclothems some of the units were never deposited. Although any of the units of the complete cyclothem may be locally or generally lacking, the uniformity of individual cyclothems and the widespread persistence of beds only a fraction of an inch thick are outstanding characteristics.

Plant fossils may occur in the lower six units of the standard cyclothem, and fossils of marine invertebrates usually occur in the upper four units. On the basis of the occurrence of marine fossils and of the lithologic character of the units, the upper four have been interpreted as being of marine origin and the lower six as generally terrestrial.

Seven cyclothems are exposed in the Marseilles-Ottawa-Streator area and in them beds 1, 4, 5, 8, 9, and 10 are most uniformly present. Six additional higher cyclothems that are well exposed on the west side of the LaSalle anticline in the LaSalle quadrangle are believed to occur in the southwest part of the Streator quadrangle, and in them units 4, 5, 8, and 9 are most uniformly present. The lower cyclothems consist largely of sandstone and gray shale (units 1, 6, and 10), include coals thick enough to be commercially important, and have only thin limestones, whereas in the upper cyclothems unit 9, consisting of thick limestones with associated calcareous shales, some of which are red, forms over half of the cyclothems, the coals are thin, and the sandstones are absent or locally represented by thin red shale. These differences appear to be restricted to northern Illinois.[31]

The boundary between successive cyclothems is placed at the base of the sandstones because the unconformity observed at this position has been regarded as indicative of an important break in deposition, and because of the change from marine to nonmarine sedimentation. Other lesser unconformities are rarely found within the cyclothems. The basal sandstones locally fill channels deeply eroded in the underlying strata. The deepest channel in the Marseilles-Ottawa-Streator area is about 60 feet deep and occurs at the base of the Vermilionville sandstone (p. 124). An unconformity within a cyclothem occurs near Streator where the upper surface of the Vermilionville sandstone appears to have been channeled before deposition of the Herrin (No. 6) coal.

With one exception the cyclothems in northern Illinois are universally present where they should be although they vary laterally in thickness and altitude (fig. 43). The one exception is the Lowell cyclothem which apparently thins out and disappears in the eastern part of the area.

[30]Wanless, H. R., Op. cit., unpublished manuscript.

[31]Northern Illinois as used in this chapter includes the part of the Illinois coal basin along the upper Illinois River and its tributaries above the Big Bend at Hennepin, and western Illinois includes the area west of Illinois River below the Big Bend.

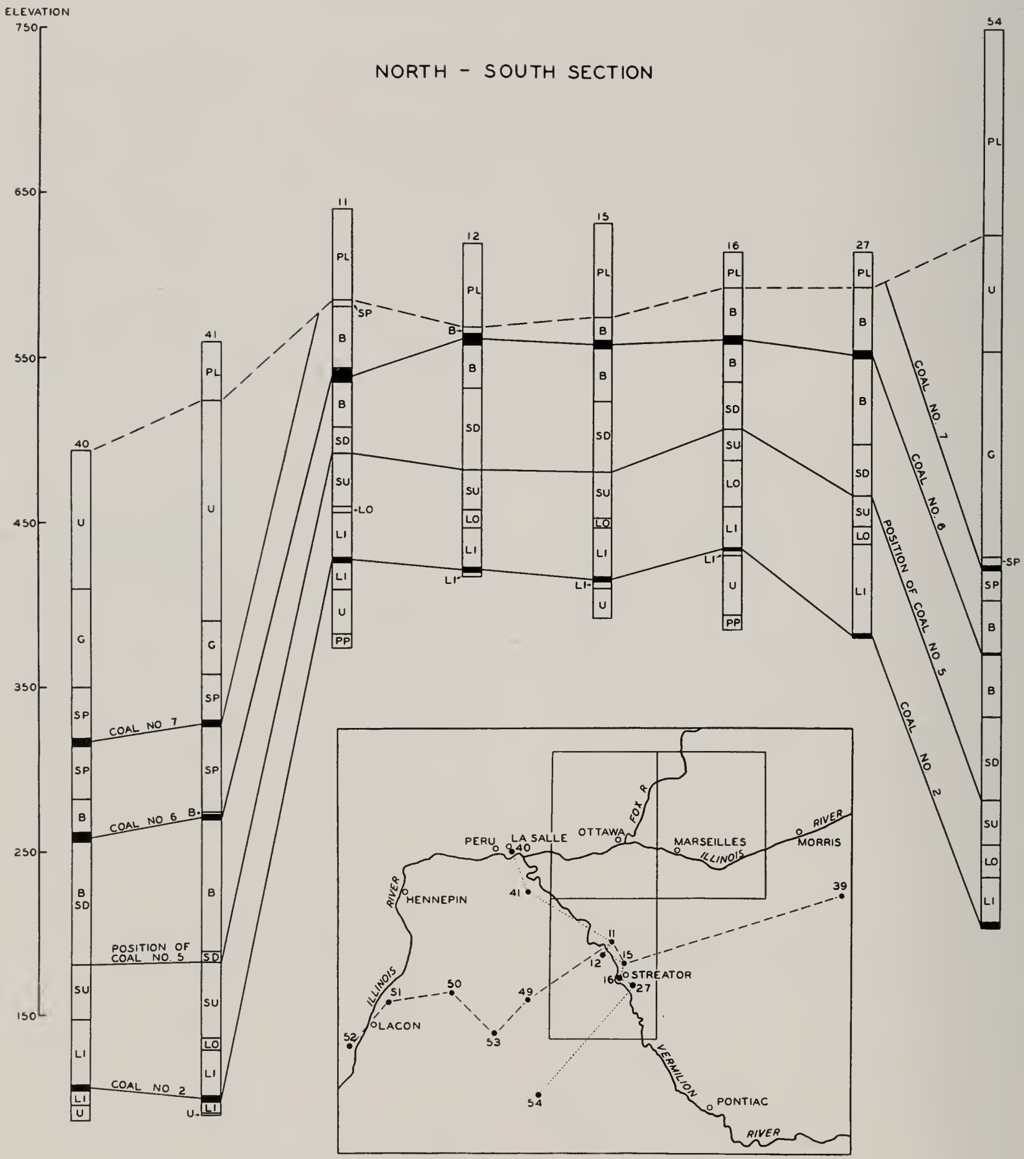



FIG. 43A.—Graph showing north-south variations in thickness and elevation of cyclothems and coals in borings and shafts in northern Illinois (records in appendix B).

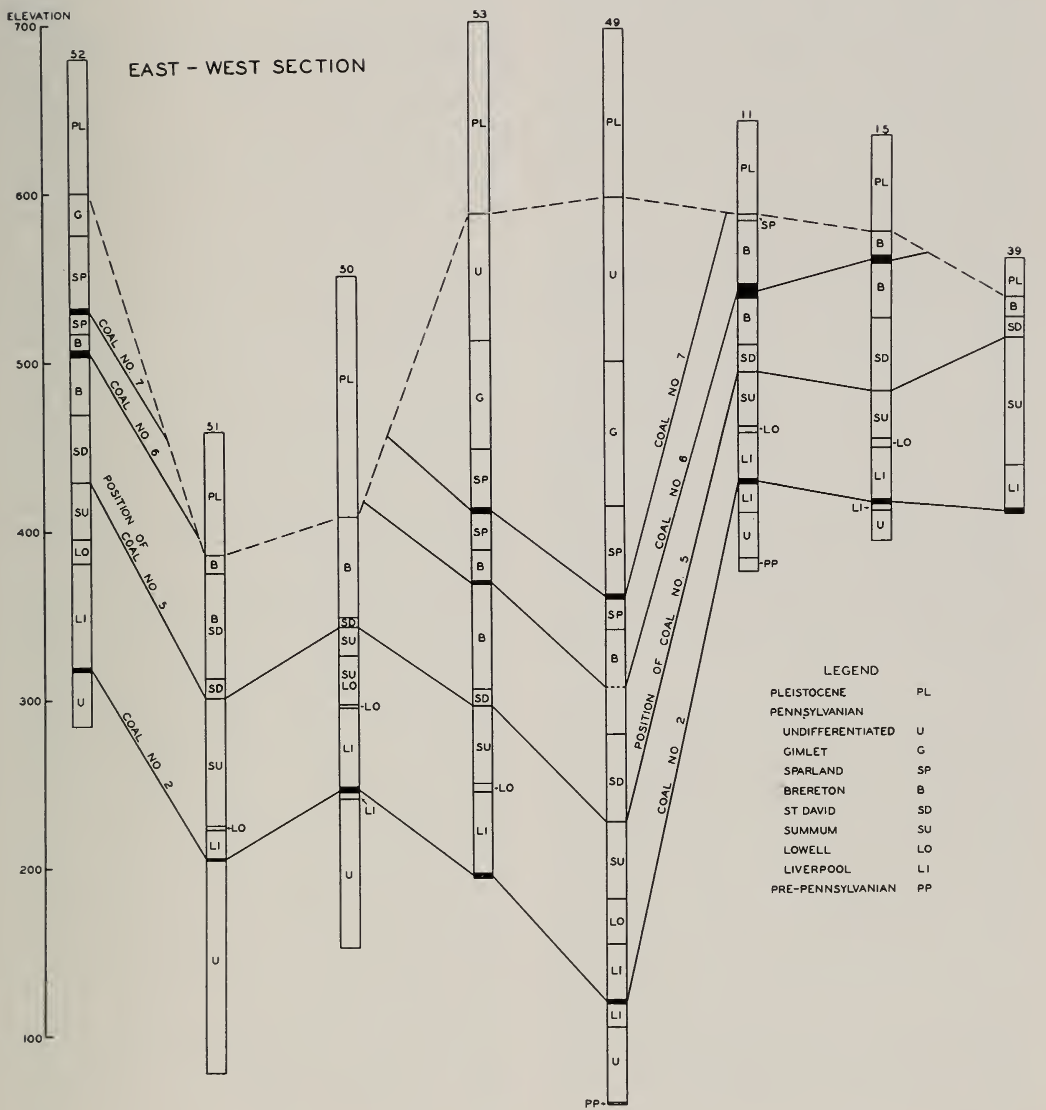



FIG. 43B.—Graph showing east-west variations in thickness and elevation of cyclothems and coals in borings and shafts in northern Illinois (records in appendix B).

## General Character of Lithologic Units

Few of the lithologic units in the various cyclothems are sufficiently distinctive to be certainly differentiated from the same units in other cyclothems. Within each cyclothem, however, most of the units are distinctive, even the same types of rocks such as the three limestone units usually having distinguishing characters. The general character of the lithologic units in the Marseilles-Ottawa-Streator area is briefly described below:

*Sandstone.*—The basal unit of the cyclothems as now defined is sandstone. All of the sandstones are silty and many are clayey. They commonly grade both laterally and vertically to sandy shale or siltstone. The sand consists of angular quartz grains nearly all of which have a few crystal faces of secondary quartz. Large flakes of mica are abundant, especially along the bedding-planes. Fresh and weathered grains of feldspar are common. A small amount of zircon, tourmaline, rutile, leucoxene, and locally garnet is present. Carbonaceous matter is common and locally colors the sandstone dark gray or black.

The sandstones are massive in some areas and thin-bedded in others, and not uncommonly the two extremes are interlayered. Individual beds as much as 5 feet thick are common, especially in the filled channels. Cross-bedding is locally present. Small ironstone concretions, generally from ¼ to 1 inch in diameter, usually altered to limonite, occur along or near the base of the sandstone in the channels and give it a conglomeratic appearance, although it is not a true conglomerate. Although they are locally noncalcareous, most of the sandstones contain a small amount of calcite irregularly disseminated through them. In some places spheroidal or discoidal masses of the sandstone as much as 5 feet in diameter have been firmly cemented by calcite. These masses, called "millstone concretions" (fig. 72), are resistant to weathering and accumulate like boulders along some stream-valleys eroded through the sandstones. In the upper cyclothems where sandstones are lacking, they are locally replaced by micaceous red slightly sandy shale.

*Sandy shale.*—The basal sandstones usually grade upward into gray sandy shales from which they can rarely be separated, especially where they are silty or clayey. The sandy shales frequently in turn grade upward into the underclays of the coals, the bedding of the shales becoming less distinct and the amount of sand gradually diminishing. This unit is poorly defined in the cyclothems of the Marseilles-Ottawa-Streator area but is better developed elsewhere in Illinois.

*Limestone.*—The lowermost of the three limestones in the standard cyclothem occurs at the base or in the lower part of the underclays. These lowermost limestones are fine-textured, compact, and light gray. Many of them weather whitish. They are usually argillaceous and commonly all or parts of them grade laterally to a discontinuous layer of rough-surfaced, irregular-shaped nodules in clay. They contain no fossils in this area and are called "fresh-water" limestones.

*Underclay.*—Although the clays which occur below the coals are commonly called "fireclay," the name underclay is preferable as most of them are not true fireclays or refractory clays. The underclays are mostly medium-gray except in the upper few inches, which is dark gray or nearly black. The fracture surfaces through several inches of the clay immediately below the dark gray clay are commonly stained brown with limonite. The underclays are not bedded, although traces of bedding-planes may occur near the base where they grade into the underlying shale or sandstone. Many of the clays fracture along smooth slickensided surfaces which extend in all directions through the clay but are rarely as much as 6 inches long. The upper parts of the clays are usually noncalcareous and the lower parts calcareous, but in some cases the entire clay is noncalcarous. The noncalcareous zone is commonly of a uniform thickness over considerable areas. Small irregular-shaped limestone nodules occur in the calcareous clays. Most of the underclays are composed of the clay mineral illite but one of them is composed of kaolinite.

*Coal.*—The coal beds are composed of brilliant bands of vitrain interlaminated with bright bands of clarain in varying proportions, with lesser amounts of fusain in thin lenses and small fragments. They break readily parallel to the bedding along surfaces commonly bordered with a film or layer of fusain or along partings which consist of films, lenses, or even fairly continuous layers of clay or shale. Also they tend to fracture vertically along sets of joint-planes intersecting nearly at right angles. The jointing, or cleat, is not well developed, so that large lumps of broken coal are only roughly rectangular.

All the coals contain more or less pyrite. Some occurs as stony or earthy pyrite between the coal layers, some as nodular concretionary masses or as minute crystals within the coal layers, and some as vein-like fillings in vertical cracks running across the bedding. Calcite and kaolinite also occur as vein-like fillings.

*Shale.*—Two different gray or greenish-gray shales, both among the less common units in the cyclothems, may separate the coal beds from overlying limestone or black shale. The lower of the two shales is the roof shale of the coals and is similar to the shale at the top of the cyclothem, but differs in locally containing plant fossils and usually lacking fossils of marine invertebrates. When this shale is present it is the top member of the nonmarine part of the cyclothem. The upper of the two shales is similar but is thin-bedded, calcareous, and contains marine fossils. It is usually less than 5 feet thick. When present this shale marks the initial deposit of the marine part of the cyclothem.

*Limestone.*—The middle limestone is a distinctive black argillaceous limestone or calcareous shale, usually crowded with white fossils and usually less than two inches thick. It is present in only a few cyclothems but in these it is a persistent bed.

*Shale.*—The hard black shale, called "slate" by coal miners, occurs in very thin uniform beds along which it can be split into large sheets. When soaked in water it does not soften and become plastic like the gray shales. It contains much organic matter and when heated gives off inflammable oily fumes. Some of the black shales contain small spherical concretions which flex the beds and give them a pustulate appearance. Large black limestone or ironstone concretions called "niggerheads" are common and the shale is locally contorted where these occur in abundance. The black shales usually have a sharp contact with the adjacent limestone units but where the upper limestone is missing the black shale commonly grades into the overlying gray shale through a zone in which the hardness decreases, the beds become thicker, and the color becomes lighter. Locally the black shales are medium- to thick-bedded and have a blocky fracture. In several cyclothems they are soft and mottled black and gray or greenish-gray. Marine fossils are locally abundant.

*Limestone.*—The uppermost limestone is usually the thickest and most continuous limestone in the cyclothems. It is often a massive single ledge of fine-grained light gray limestone which weathers light buff, but many different types of limestone occur at this horizon. Locally it is thin-bedded or consists of several beds separated by shale. Some of the limestones are nodular and grade laterally and vertically to nodules in shale. Many are argillaceous but a few are not. Some are brecciated. The limestone is predominately very fine-grained although mixtures of crystalline and fine-grained stone occur. Crinoidal beds are locally present. Marine fossils are common. In the upper cyclothems the uppermost limestones are especially well developed and frequently consist of two ledges of limestone separated by several feet of gray and red calcareous shale containing lenses and nodules of limestone. Because of the variety of types of rock the uppermost limestones are usually the most distinctive members of the cyclothems.

*Shale.*—The top member of the cyclothem is a shale, gray or greenish-gray in color except in the lower few feet which is dark gray or bluish-gray. It is usually the thickest shale in the cyclothem, although locally it is exceeded by the shale overlying the coal. The lower 2 to 5 feet of these top shales is thin-bedded, above which the beds are mostly ¼ to 2 inches thick. Discoidal concretions of limestone and ironstone are common, especially in the lower 5 feet, and they usually occur at definite horizons. The ironstone concretions are largely siderite (iron carbonate) mixed with a little clay and in some cases with calcium carbonate. Where the shales are thick the upper part is sandy and locally contains thin beds of sandstone. Marine fossils occur in the lower part of the shale.

### Correlation Methods

The correlation of individual beds from place to place is often difficult because of the similarity of the rock types in the different cyclothems. However, a few beds have distinctive characters which make their identification easy. The Covel conglomerate, for example, is unlike any other beds in the area and is therefore a valuable guide bed. Some beds have characters which enable their correlation in limited areas. The lower part of the black shale in the St. David cyclothem contains large numbers of *Aviculopecten rectilaterarius* which distinguishes it from other black shales in northern Illinois. Some limestone beds have a great abundance of a particular fossil or a distinctive group of fossils which aids in their local identification.

Where the same lithologic units in different cyclothems are so similar as to be indistinguishable, correlations are based on the similarity of sequences and stratigraphic position with relation to identifiable beds. The cyclothems are rarely complete and some cyclothems may lack beds which are present in others, thus aiding identification. As previously noted, the cyclothems are very persistent and rarely absent where they would be expected, and this enables reasonably certain identification of many beds which may occur between distinctive beds.

### Use in This Report

In this report the Pennsylvanian system is divided into the four groups—Caseyville, Tradewater, Carbondale, and McLeansboro—and the exposed strata are further divided into the Liverpool, Lowell, Summum, St. David, Brereton, Sparland, and Gimlet cyclothems. Strata representing one or two lower cyclothems are probably present in some parts of the area but the data available from borings are not sufficient to permit their definite identification. Probably several higher cyclothems are also present in the southwest part of the Streator quadrangle, but as they are not exposed and no records are available from borings in that area, their description is based on outcrops and records of borings in the LaSalle and Wenona quadrangles west of the Ottawa and Streator quadrangles.

All of these cyclothems except the Lowell are widely distributed throughout Illinois. The Lowell cyclothem, first differentiated in the present studies, underlies a considerable area in the north part of the Illinois coal basin, and equivalent strata have been differentiated recently in southern Illinois.[32]

In this report cyclothems are used as the fundamental units of classification of the Pennsylvanian strata, with subdivisions into stratigraphic units which are essentially lithologic units. For convenience in describing the stratigraphic sequence, every bed which can be differentiated and has been traced far enough to indicate that it is not extremely local is separated as a stratigraphic unit. Gradational phases between beds and more or less continuous beds of concretions are not differentiated. In a few cases beds of closely related character or thin beds of variable lithologic character and very local distribution are grouped as a single unit. Most of the stratigraphic units correspond to the lithologic units of the standard cyclothem, and consequently the latter are not specifically differentiated in the stratigraphic descriptions. As previously noted, some of the lithologic units of the ideal cyclothem actually are variable in lithology. For example, the limestones frequently consist of several beds of limestone and shale many of which are distinctive. In these cases the lithologic units are subdivided into several stratigraphic units.

The cyclothems and some of the stratigraphic units in the Marseilles-Ottawa-Streator area have been previously named

[32]Wanless, H. R., personal communication.

for some locality elsewhere in Illinois where they are especially well developed or are of commercial importance. Where the correlations seem reasonably certain these names are applied to equivalent units in this area.

For a convenient means of referring to numerous unnamed beds and of identifying and relating the beds listed in the geologic sections and records of borings included in this report, the stratigraphic units in the Marseilles-Ottawa-Streator area are numbered in succession upward from the base of the Pennsylvanian system. These numbers serve only as index numbers in this report and have no relation to numbers used in other reports.

### CASEYVILLE GROUP[33]

No strata belonging to the Caseyville group are definitely known in the Marseilles-Ottawa-Streator area, but it is possible that there may be some at the base of the Pennsylvanian system in the southwest part of the Streator quadrangle, west of the LaSalle anticline.

### TRADEWATER GROUP[34]

The oldest known Pennsylvanian strata in the Marseilles-Ottawa-Streator area, which are reported only in records of borings in the Marseilles and Streator quadrangles, are believed to belong in the Tradewater group.

*Distribution and thickness.*—The Tradewater strata, which lie below the underclay of the Liverpool cyclothem in the Carbondale group, are thickest in the southern part of the Streator quadrangle and the eastern part of the Marseilles quadrangle. They thin out to the north and west so that they are lacking in the Ottawa quadrangle. If the lower part of the underclay of the Liverpool cyclothem (p. 98) contains beds belonging in the Tradewater group, the distribution of the Tradewater group would be accordingly extended. Allowing for the underclay of the Liverpool cyclothem, which is uniformly present and generally about 5 feet thick, rarely more than 10 feet, the map showing the thickness of the Pennsylvanian strata below coal No. 2 in the Ottawa and Marseilles quadrangles (fig. 44) depicts chiefly the variations in the thickness of the Tradewater group. It would be generally absent where the total thickness is shown as less than 10 feet and probably also in parts of the areas where the total thickness is between 10 and 20 feet, but it probably underlies all the areas where the total thickness is more than 20 feet.

*Lithology.*—The shale reported below the "fireclay" below coal No. 2 in many wells in the east part of the Marseilles quadrangle is probably part of the Tradewater group, although it may be equivalent to beds in the lower part of the Carbondale group. The maximum recorded thickness of the shale is 20 feet.

Brown sandstone reported at the base of the Pennsylvanian system in well records a short distance east of the Marseilles quadrangle may be present locally at the base of the Pennsylvanian in the eastern part of the Marseilles quadrangle. Its correlation is uncertain but it probably belongs in the Tradewater group.

Accurate information concerning the character of the basal Pennsylvanian strata in the Streator quadrangle is scant because few borings extend below the base of LaSalle (No. 2) coal. The shaft (app. B, 11) of an abandoned mine at Heenanville in the SE. ¼ NW. ¼ sec. 10, T. 31 N., R. 3 E., (Bruce Twp.), passed through 27 feet of dark shale below a sandstone which might belong in either the Tradewater or the Carbondale group. The record of a boring (app. B, 1) about two miles northeast of the mine shows 26 feet of sandy shale at the base of the Pennsylvanian, and the sandstone is either absent or included in the sandy shale. Farther south at Streator several units of a cyclothem below the underclay of coal No. 2 are reported in a boring (app. B, 15) in the SE. ¼ NW. ¼ SW. ¼ sec. 24, T. 31 N., R. 3 E. (Bruce Twp.). The base of the Pennsylvanian strata was not reached and so representatives of still lower cyclothems also may be present. All of these reported strata are assigned to the Tradewater group, although some of the upper ones may belong in the Carbondale group.

[33]Named for Caseyville, Union County, Kentucky, near which it is exposed. Glenn, L. C., Kentucky Geol. Survey Rept. Prog., p. 27, 1910 and 1911.

[34]Named for Tradewater River east of Battery Rock, Kentucky, along which it is exposed. Glenn, L. C., Kentucky Geol. Survey Rept. Prog., p. 27, 1910 and 1911.

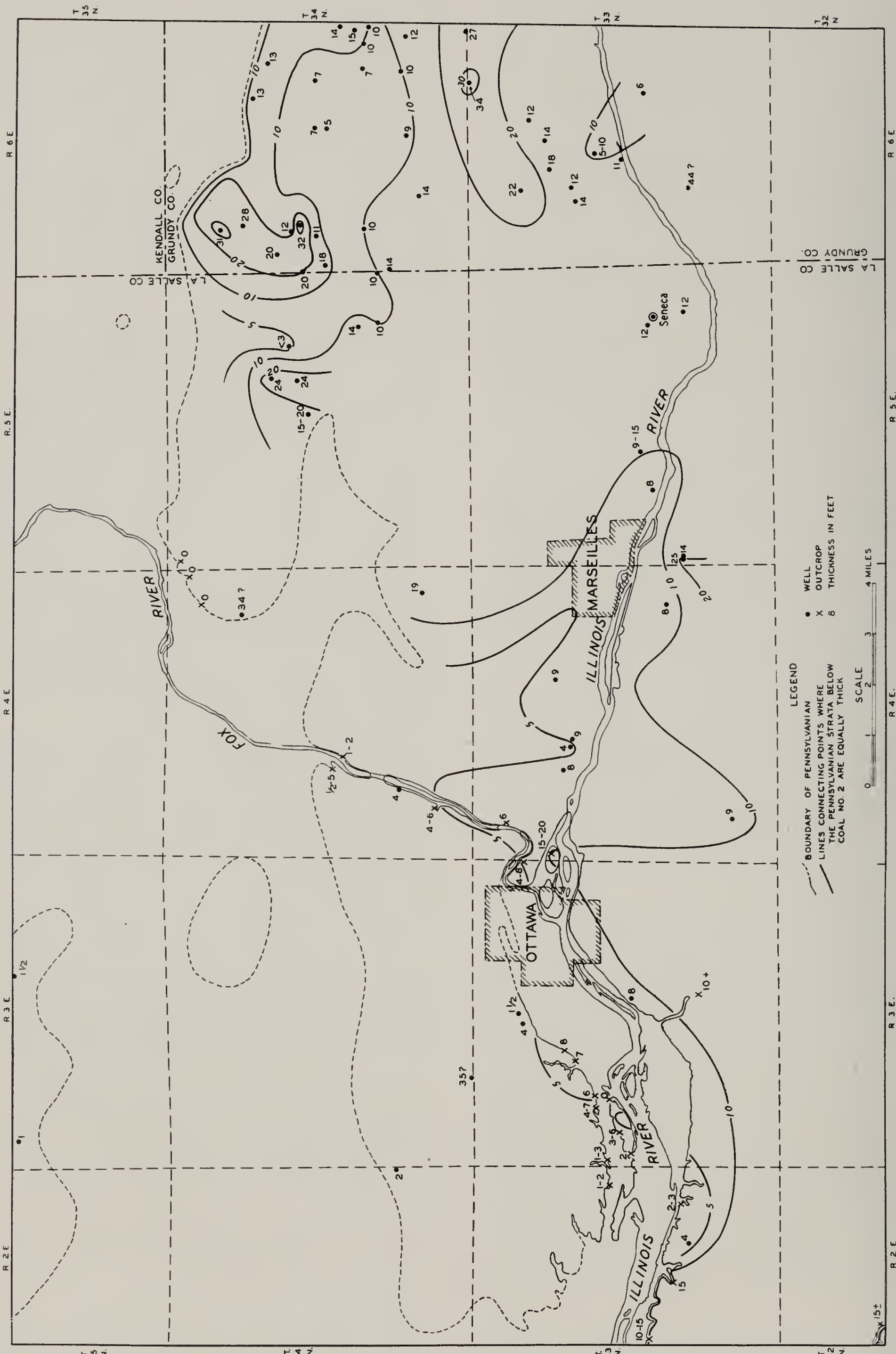



FIG. 44.—Thickness of Pennsylvanian strata below the LaSalle (No. 2) coal in the Marseilles and Ottawa quadrangles.

Deep borings west of the LaSalle anticline in the LaSalle and Wenona quadrangles (app. B, 40, 49, 50, 51) penetrate pre-Liverpool strata belonging to three or four cyclothems, and some of them probably underlie also the southwest part of the Streator quadrangle.

*Stratigraphic relations.*—The Tradewater group lies unconformably upon Ordovician strata (p. 84). The character of the contact between the Tradewater and Carbondale groups, which is placed at the base of the Liverpool underclay in the Marseilles-Ottawa-Streator area, is not known, as it is not exposed and the relationship cannot be determined from records of borings.

## CARBONDALE GROUP[35]

The Carbondale group includes the Lower Liverpool, Liverpool, Lowell, Summum, St. David, and Brereton cyclothems. All except the Lower Liverpool are exposed in the Marseilles-Ottawa-Streator area. However, the upper part of the unexposed beds which have been placed in the Tradewater group may include some representatives of the Lower Liverpool, and it is also possible that some of the Liverpool underclay may be equivalent to part of the Lower Liverpool cyclothem.

*Distribution.*—All the Pennsylvanian beds exposed in the Marseilles and Ottawa quadrangles and those exposed along Vermilion River in the Streator quadrangle northwest of the Streator waterworks dam about a mile southeast of Streator (pl. 11) are in the Carbondale group.

*Thickness.*—The Carbondale group is 175 to 200 feet thick in the area where it is overlain by the McLeansboro group. Elsewhere the upper part has been eroded and its thickness is less.

*Stratigraphic relations.*—In the east part of the Marseilles quadrangle and the south part of the Streator quadrangle, the Carbondale group lies on older Pennsylvanian strata but elsewhere it lies on the St. Peter, Galena, Decorah, and Platteville formations of the Ordovician system, forming the major unconformity previously described (p. 84).

### Liverpool Cyclothem[36]

The Liverpool cyclothem consists of approximately 96 per cent clay and shale, 3 per cent coal, and 1 per cent limestone and is divided into eight stratigraphic units, some of which are named (fig. 45). It is important economically because the underclay, the coal, and the shale over the coal each furnish raw material for extensive industries.

*Distribution and outcrops.*—The Liverpool cyclothem is present throughout the entire area underlain by Pennsylvanian strata (pl. 11). Outcrops are common along Illinois and Fox valleys in the Ottawa quadrangle and along Vermilion River in the Ottawa and Streator quadrangles below Sandy Ford, but in the Marseilles quadrangle they are limited to small areas (1) along Illinois River near the west side of the quadrangle and (2) near Classon School along Brumbach Creek, a tributary to Fox River. The entire cyclothem is exposed in a single bank along Covel Creek in the SW. ¼ SE. ¼ NW. ¼ sec. 27, T. 33 N., R. 3 E. (South Ottawa Twp.), and in several outcrops along the tributary to Vermilion River southeast of Vermilionville, in the SW. ¼ sec. 10, T. 32 N., R. 2 E. (Deer Park Twp.), Ottawa quadrangle.

*Thickness.*—The Liverpool cyclothem is commonly about 50 feet thick, but it varies from 25 to 60 feet in thickness principally because of variations in the thickness of the basal underclay which was deposited on an uneven surface. The minimum thickness occurs in a limited area where the shale over the coal is unusually thin.

*Stratigraphic relations.*—The Liverpool cyclothem is overlain apparently conformably by the Lowell cyclothem in the Streator quadrangle and the southwest part of the Ottawa quadrangle. Elsewhere it is overlain by the Pleasantview sandstone of the Summum cyclothem with a contact generally gradational but locally sharp. The absence of the limestone (Unit 7) and the black shale (Unit 6) east of

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[35]Named for Carbondale in Jackson County, Illinois, near which it is well exposed. Shaw, E. W., and Savage, T. E., U. S. Geol. Survey Geol. Atlas, Murphysboro-Herrin folio (No. 185), p. 6, 1912.

[36]Wanless, H. R., Pennsylvanian cycles in Western Illinois: Illinois Geol. Survey Bull. 60, p. 188, 1931. Named for Liverpool township, Fulton County, Illinois.

| Stratigraphic Unit Number | Section | Thickness | Material | Name |
|---|---|---|---|---|
| 8 | | 0 - 13′ | SHALE, SANDY, GRAY | |
| 7 | | 0 - 3′ | LIMESTONE, GRAY, SEPTARIAN | |
| 6 | | 0 - 3′ | SHALE, BLACK, HARD, SHEETY | |
| 5 | | 10′ - 50′ | SHALE, GRAY; UPPER PART SANDY | FRANCIS CREEK |
| 4 | | 2″- 4′ | COAL | LA SALLE (NO. 2) "THIRD VEIN" |
| 3 | | 0 - 9′ | CLAY, GRAY, SANDY | |
| 2 | | 0 - 3′ | CLAY, GREEN | |
| 1 | | 0 - 14′ | CLAY, GRAY, SANDY | |

Fig. 45.—Generalized section of the Liverpool cyclothem.

Illinois Canyon is probably due to nondeposition rather than erosion as the black shale thins out before the overlying limestone.

*Correlation.*—The correlation of the cyclothem with its type area in western Illinois has been made by tracing the coal and its associated beds in outcrops and borings in the intervening area. However, in northern Illinois only the strata as high as the lower part of the Oak Grove unit in western Illinois are included in the Liverpool cyclothem, and equivalents of the upper part of the Oak Grove unit and the overlying Purington shale of western Illinois are included in the Lowell cyclothem (p. 102), which has not been differentiated in western Illinois.

### STRATIGRAPHIC UNITS

#### *Underclay (Units 1-3)*

*Distribution and outcrops.*—The underclay of LaSalle (No. 2) coal is one of the most continuous beds in the Pennsylvanian system in the Marseilles-Ottawa-Streator area and is present throughout practically the entire area underlain by the system. The underclay crops out at many places in the Illinois Valley bluffs and in the tributary ravines west from Ottawa to Starved Rock on the south side and to Higbee Ravine on the north side, along Fox Valley from Ottawa north to one mile south of Sulphur Springs, and along Vermilion River in the southwest corner of the Ottawa quadrangle and the northwest corner of the Streator quadrangle. Natural outcrops of the clay are usually badly slumped, and the best sections are exposed in the clay pits and in the overburden of the St. Peter sandstone pits between Twin Bluffs and Higbee Ravine and at Buffalo Rock.

*Thickness.*—The underclay is usually 2 to 8 feet thick but varies from a trace to approximately 20 feet thick. Rarely it is entirely absent, as in the road-cut at the east end of Buffalo Rock, where LaSalle (No. 2) coal rests directly on the St. Peter sandstone (fig. 46). It is more than 10 feet thick in only a few outcrops along the west margin of the Ottawa quadrangle near Starved Rock, locally in the vicinity of the clay pits east of Ottawa, and at Lowell. Where thick it may include other underclays. Its thickness in the Ottawa quadrangle and the west part of the Marseilles quadrangle, where no other strata intervene between the LaSalle (No. 2) coal and the Ordovician strata, is shown in figure 44. The thicker deposits of clay occur in the channels in the Ordovician formations (p. 84). Unusually great thicknesses, as much as 125 feet, of clay continuous and probably contemporaneous with the underclay occur in the pockets in the St. Peter sandstone (p. 78, fig. 35) and in the caves in the Platteville limestone (p. 81, fig. 39). Some wells whose records show great thicknesses of clay below the coal are probably located in a pocket or cave deposit, especially as in such cases the great thickness of clay is usually complemented by a corresponding decrease in thickness of the Ordovician strata.

*Lithology.*—Usually the underclay is a gray noncalcareous clay, with varying amounts of sand. However, where it is 8 to 10 feet or more thick, it commonly consists of three beds—a lower gray clay (Unit 1), 5 to 14 feet thick; a thin discontinuous green clay or shale (Unit 2), 2 inches to 3 feet thick; and an upper gray clay (Unit 3), 3 to 9 feet thick. This sequence of clays was formerly well shown in pits near Starved Rock (geol. sec. 10)[37] and east of Ottawa (geol. sec. 6) and in a shaft mine two miles east of Marseilles (geol. sec. 2). In the south part of the abandoned clay pits east of Ottawa the green clay is reported to have been found at about the middle of the clay deposit but in the north part it rested directly on the St. Peter sandstone, although everywhere it was approximately the same distance below the coal.

The gray clays vary from light to medium, with the upper foot of the top clay locally darker than the rest. The green clay is uniformly light grayish-green. Nearly all the clay is sandy, and the amount of sand varies greatly in short distances. Locally the clay contains as much as 25 per cent sand. The clay appears to be less sandy where it is thick and where it overlies the Ordovician limestone. In a pit near Starved Rock where the clay overlies limestone, the lower gray clay contains about 0.5 per cent sand, the green clay only a trace, and the upper gray clay 4 per cent. The sand grains are well distributed throughout the clay, and usually no sorting or stratification is recognizable, but locally, as on the top of Buffalo Rock, lenses of nearly pure sand occur in the clay. In a pit east of Ottawa a lens of sandstone 1 to 4 feet thick is reported to have occurred below the green clay.

[37]The geologic sections are given in appendix A.

Fig. 46.—LaSalle (No. 2) coal overlying the St. Peter sandstone and overlain by the Francis Creek shale in road-cut at the east end of Buffalo Rock, SW. ¼ NE. ¼ SW. ¼ sec. 17, T. 33 N., R. 3 E. (Ottawa Twp.), Ottawa quadrangle.

That the sand is derived from the St. Peter sandstone is demonstrated by the appearance and size of the grains. Sand washed from the upper clay exposed in a pit near Starved Rock has the following sieve analysis:

| Mesh | Per cent retained | Mesh | Per cent retained |
|---|---|---|---|
| 28 | 2 | 100 | 17 |
| 35 | 7 | 150 | 5 |
| 48 | 21 | 200 | 7 |
| 65 | 34 | 270 | 7 |

This sand is only a little finer grained than the average St. Peter sandstone (p. 73), and grains almost 1 mm. in diameter, about the maximum size abundant in the St. Peter, are common.

At a few places the underclay contains nodules and lenses of limestone but usually they are rare. Several are exposed along the west side of Covel Creek in the SW. ¼ SE. ¼ NW. ¼ sec. 27, T. 33 N., R. 3 E. (South Ottawa Twp.), Ottawa quadrangle. The limestone occurs in sharply tapering lenses as much as 1 foot thick and usually less than 10 feet long, and in nearly spherical boulder-like masses generally less than a foot in diameter, 4 to 6 feet below the top of the underclay. The limestone is a mixture of light greenish-gray argillaceous limestone and brown finely crystalline limestone which weathers irregularly light gray or rusty brown. Clusters of pyrite crystals are abundant. Cone-in-cone occurs along the top of the lenses and completely surrounding the nodules. The limestone is nonfossiliferous. Boulder-like masses of limestone composed of small spherical grains and called "pisolitic" boulders, have been found in the upper part of the underclay in the pits east of Ottawa (geol. sec. 6).

Black carbonaceous material, partly bright coal, occurs in thin streaks which can be traced for a foot or more and are usually broken at slickensided surfaces. They are probably root traces.

*Mineral composition.*—The underclay consists largely of the clay minerals kaolinite and illite. Pyrite and quartz are common. Gypsum and an unidentified mineral are locally common and small grains of tourmaline and zircon are also present.

In the pits east of Ottawa the gray underclay consists largely of kaolinite but a minor amount of illite is present.[38] The clay at Lowell is similar but contains a larger amount of illite. The green clay is probably largely illite.

The mineral pyrite varies in abundance but is almost universally present. It ranges from minute perfect crystals in an unusual variety of forms, mostly octahedrons, pyritohedrons, dodecohedrons, and less commonly cubes, to groups of crystals forming nodules several inches in diameter. Pyrite is especially abundant in the green clay.

At several places in the area gypsum forms an almost continuous band from a trace to an inch thick along the top of the underclay at the base of coal No. 2. The gypsum occurs in transparent acicular crystals at right angles to the contact with the coal. At some places the gypsum is split into several bands by discontinuous streaks of carbonaceous material. Locally gypsum occurs in small radial groups of acicular crystals scattered through the underclay.

An unidentified mineral was fairly common in sand separated from the clay from a pit near Starved Rock. It is white, fibrous, opaque, soft, and talc-like, and occurs in cylindrical forms and radial groups of prismatic or acicular crystals. It may be a clay mineral in pseudomorphs after gypsum.

Several grains of tourmaline and zircon were found in the sand screened from the underclay, especially in the fractions on the 65-mesh and finer screens. They appear to be at least as abundant and are as large as those in the St. Peter sandstone.

*Chemical composition.*—The chemical composition of the underclay is shown by the analyses of samples 206, 211, W-28, W-29 (app. H, table 1).

*Ceramic character.*—The gray underclay is generally refractory in the area in which it crops out and in several mines near Marseilles, but in mines at Seneca, Streator, and Kangley it is nonrefractory. Its ceramic properties (p. 243) are shown by tests of samples W-28 and W-29 (app. J). The green clay is nonrefractory.

*Structural features.*—The gray clay fractures into irregular fragments, many of which have smooth, glossy, and slickensided surfaces on which are tiny knobs at the positions of sand grains. Individual slickensided surfaces may be 6 or more inches long but usually are much shorter. The green clay is faintly bedded with parallel and closely spaced bedding-planes.

*Correlation.*—The correlation of the clay with similar deposits in western Illinois is based on the relation of the clay to coal No. 2, the fact that in both areas it is the only thick refractory clay, and the presence in both areas of pisolitic boulders which are rare, if present, in other underclays. This is also the only underclay which is largely kaolinite.[39]

It is possible that only the upper part of the underclay (Unit 3) belongs in the Liverpool cyclothem. The green clay or shale (Unit 2) and the lower clay (Unit 1) may represent lower cyclothems. This succession is similar to that in southwestern Illinois near Alton where the underclays of several cyclothems are thought to converge and form a thick

[38]Grim, R. E., Petrology of the Pennsylvanian shales and noncalcareous underclays associated with Illinois coals: Am. Ceramic Soc. Bull., vol. 14, p. 172, 1935.

[39]Grim, R. E., personal communication.

deposit of clay.[40] A distinctive green clay or shale similar to Unit 2 is a widespread unit underlying the Seahorne limestone in the Seahorne cyclothem of western Illinois.

*LaSalle (No. 2) coal*[41] *(Unit 4)*

*Distribution and outcrops.*—The LaSalle (No. 2) coal is one of the most continuous beds in the Pennsylvanian system, and as it is reported in nearly all wells and borings which penetrate its horizon, it is believed to underlie all of the Marseilles-Ottawa-Streator area in which Pennsylvanian strata occur.

Along much of its boundary line (pl. 12), the coal is buried by surficial deposits but it is exposed at many places in the bluffs of Illinois Valley west from Ottawa to Starved Rock Park on the south side and to Higbee Ravine on the north side (fig. 46). In the west part of the Ottawa quadrangle the coal crops out at the top of the bluffs but lies at lower elevations farther east and occurs at the elevation of Illinois River about two miles east of the Ottawa highway bridge.

The coal also crops out along Fox River from Ottawa to about a mile south of Sulphur Lick Springs and along Vermilion River in the southwest corner of the Ottawa quadrangle and the northwest corner of the Streator quadrangle.

*Thickness.*—The coal averages between 2 and 3 feet but varies, usually gradually, from 2 inches to 4 feet 2 inches thick. The coal is generally thinnest in the upland area northwest of Ottawa where wells commonly record less than 2 feet of coal, at several places less than 6 inches, but it thickens to the south and east. Southward, in the vicinity of Buffalo Rock it varies from 1 foot 6 inches to 1 foot 11 inches thick, in Starved Rock Park it is 2 feet 3 inches thick, at Lowell it varies from 2 feet 6 inches to 3 feet 3 inches thick, in the Kangley mine it averaged 2 feet 8 inches thick, and in mines at Streator it averaged 3 feet thick. Eastward, at the clay pits east of Ottawa, it is a little less than 2 feet thick, in the vicinity of Marseilles it is 2 feet 6 inches thick, and in a mine at Seneca it averaged 3 feet and locally was as much as 4 feet 2 inches thick.

*Lithology.*—The coal bed is composed of common bright banded coal, consisting of alternating bands of brilliant jet-black vitrain and bright finely laminated clarain which appears relatively duller than the vitrain. Fusain, or "mother coal," occurs in thin lenses, particularly near the middle of the bed. The coal contains no persistent partings and is not benched. It breaks most readily parallel to the bedding.

Pyrite is common in lenses, irregular nodules, or "balls," in the form of disseminated crystals, and as more or less vertical veinlets; it locally impregnates fusain, making it hard. Calcite occurs as "facings" filling joint cracks, and kaolinite is almost entirely restricted to joints or shrinkage cracks in the vitrain. Gypsum is locally present in thin bands near the base of the coal.

*Correlation.*—In northern Illinois, coal No. 2 has been variously called the LaSalle or "Third Vein" coal, the Morris coal, and the Wilmington coal. Its correlation with the Colchester (No. 2) coal of western Illinois was suggested early in the study of the "Coal Measures" strata,[42] and was substantiated by later studies of outcrops, mines, and drill records.[43] The similarity of many of the beds overlying the LaSalle (No. 2) coal to those overlying the Colchester (No. 2) coal further demonstrates the accuracy of the early correlation. The coals may also be correlated by borings which are well distributed between the outcrops in LaSalle County and the exposures in strip mines near Atkinson in Henry County where the associated strata are typical of the western Illinois section. The correlation of the coal between outcrops in the LaSalle-Ottawa-Marseilles area and the mines in the Streator area is shown by records of mine shafts and borings (fig. 43A and app. B, 9, 11, 12, 15, 16, 31, and others). By the same means the coal at Streator can be correlated with the "Third Vein" coal in mines at Coal City, Wenona, Minonk, Sparland, and elsewhere (fig. 43B and app. B, 39-54).

[40] Wanless, H. R., personal communication.

[41] Named after the city of LaSalle. Originally called the Lower LaSalle coal. Freeman, H. C., Geology of LaSalle County: Geological Survey of Illinois, vol. 3, p. 267, 1868.

[42] Worthen, A. H., Geology and paleontology: Geological Survey of Illinois, vol. 3, p. 11, 1868.

[43] Cady, G. H., Coal resources of District 1 (Longwall): Illinois Geol. Survey Coal Min. Inves. Bull. 10, p. 60. 1915.

*Francis Creek shale*[44] (*Unit 5*)

*Distribution and outcrops.*—The Francis Creek shale (Unit 5, fig. 45), which lies immediately above coal No. 2, crops out extensively along Illinois Valley. It is the highest bedrock from Higbee Ravine east to the Twin Bluffs pit of the National Fireproofing Company (fig. 46) along the north side, and in and immediately adjacent to Starved Rock State Park on the south side. East to Ottawa the shale occurs lower in the bluffs and is overlain by younger bedrock strata. In the Ottawa quadrangle east of Ottawa it underlies much of the valley-floor, is well exposed in several pits and strip mines, and farther east, in the Marseilles quadrangle, it crops out in a narrow belt extending to about half a mile below the bridge at Marseilles.

The shale also crops out at many places along the lower Fox Valley from its mouth nearly to Sulphur Lick Springs and is present for about two miles in the lower part of the valley-walls of Vermilion River, from the southwest corner of the Ottawa quadrangle to the north part of sec. 22, T. 32 N., R. 2 E. (Deer Park Twp.), Streator quadrangle. East of Covel Creek, where the black shale (Unit 6) is absent, the upper part of the Francis Creek shale may include some beds equivalent to a higher shale (Unit 8) and possibly some of the shales in the Lowell cyclothem.

*Thickness.*—The Francis Creek shale is about 30 feet thick in Starved Rock State Park, 40 to 50 feet thick east of Covel Creek, 10 to 20 feet thick along Vermilion River, and 15 to 25 feet thick in borings near Streator. In mines a short distance west of the Ottawa quadrangle the shale is locally absent but reaches a maximum of 50 feet.[45]

*Lithology.*—The shale ranges from medium gray to dark gray in color, with a few red streaks present locally, as north of Dayton near the center of the east line, NE. ¼ sec. 20, T. 34 N., R. 4 E. (Dayton Twp.), Ottawa quadrangle, and along Little Horseshoe and Illinois canyons (geol. secs. 9, 11).[46] It occurs in beds mostly ¼ to 3 inches thick, and the upper part is thicker bedded than the lower. It is hard when dry but soft and plastic when wet. Where the shale is overlain by the black shale (Unit 6) it contains little sand and silt but along Covel Creek and farther east, where the black shale is absent, the upper part of the Francis Creek shale is sandy and silty. The shale, like most of the Pennsylvanian shales, is composed largely of illite.[47] Many minute flakes of mica are present, especially along the bedding-planes where they lie with their flat surfaces uniformly parallel to the bedding. Pyrite is common, especially in the lower 3 to 5 feet, both as rough nodules usually less than 2 inches in diameter and irregularly distributed as small crystals. Discoidal concretions of dark gray ironstone coated with limonite, usually less than 4 inches in maximum diameter, are also common locally in the lower 5 feet of the shale but rare in the upper part. Veinlike stringers of limestone extend irregularly through the shale in outcrops along Illinois Canyon.

The chemical composition of the shale is shown by analyses of samples 36, 204, 288, W-18, W-27, W-79 (app. H, table 1). Its ceramic properties are shown by tests of samples W-18, W-27, W-79 (app. J).

*Fossils.*—The only fossils found in the shale in the Marseilles-Ottawa-Streator area are poorly preserved traces of plants, but the world-famous fossiliferous concretions in the Mazon River region, about seven miles east of the Marseilles quadrangle, occur in the Francis Creek shale. Marine fossils are present in this shale near Atkinson, Henry County.

*Correlation.*—The Francis Creek shale is identified in the Marseilles-Ottawa-Streator area on the basis of its position above coal No. 2.

*Shale* (*Unit 6*)

*Distribution and outcrops.*—The black sheety shale (Unit 6, fig. 45), commonly called "slate," that overlies the Francis

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[44]Named for Francis Creek in Fulton County, Illinois. Savage, T. E., Significant breaks and overlaps in the Pennsylvanian of Illinois: Am. Jour. Sci., vol. 14, p. 309, 1927.

[45]Cady, G. H., Geology and mineral resources of the Hennepin and LaSalle quadrangles: Illinois Geol. Survey Bull. 37, p. 56, 1919.

[46]The geologic sections are given in appendix A.

[47]Grim, R. E., personal communication.

Creek shale occurs in most of the Streator quadrangle and the southwest part of the Ottawa quadrangle. It is exposed in the upper part of French Canyon and in Tonti Canyon (west branch of Horseshoe Canyon) in Starved Rock State Park but is absent farther north and east. It crops out along Vermilion River from the southwest corner of the Ottawa quadrangle to the center N. ½ sec. 22, T. 32 N., R. 2 E. (Vermilion Twp.), in the Streator quadrangle (geol. secs. 12, 33). According to records of borings the shale is absent near Heenanville and Kangley but is present in the vicinity of Streator. It is also present in the LaSalle quadrangle.[48]

*Thickness.*—In outcrops along Vermilion River the black shale varies from 1 to 3 feet thick. In a road-cut on the east side of Tonti Canyon the shale is 22 inches thick in the west part and only 12 inches at the east end. Borings and mine shafts at Streator encountered 3 to 5 feet of "slate."

*Lithology.*—The shale is black or very dark gray and is hard and brittle. It occurs in beds which are continuous and remarkably uniform in thickness. Although mostly about 0.5 mm. thick, they range from 0.25 to 1 mm. thick. Where weathered, the shale splits easily along many of the bedding-planes to form thin sheets. At many places the shale is broken into large rhombohedral or diamond-shaped blocks by vertical joints.

Large spheroidal or oval concretions, called "niggerheads," of dense fine-grained gray or dark gray limestone, 6 inches to 3 feet thick, are locally so abundant they crowd and intensely contort the shale. Limestone concretions only ½ inch or less in diameter are present but rarely abundant.

Mica flakes, as large as 0.1 mm. in diameter, and pyrite crystals are abundant along the bedding-planes. Where the shale is weathered, the bedding-planes are often densely matted with gypsum crystals which crowd the beds apart.

*Fossils.*—Conodonts are present but are not common. Charcoal-like plant fragments are locally present. Brown shiny transparent resinous grains, probably plant spores, occur along some of the bedding-planes of the shale near Vermilionville (geol. sec. 12).

*Correlation.*—The shale is similar to the black shale which occurs above the Colchester (No. 2) coal throughout western Illinois and records of borings indicate it is probably continuous with it. Its absence in the Marseilles and the east part of the Ottawa quadrangles is characteristic of the succession in the Morris and Wilmington quadrangles.

### *Limestone* (*Unit 7*)

A discontinuous bed of limestone (Unit 7, figs. 45, 49) overlies the black sheety shale (Unit 6). Although the limestone usually underlies the gray sandy shale (Unit 8), at a few places it occurs in shale which fills the spaces between concretionary masses of the limestone, and a short distance west of the area, in the LaSalle quadrangle,[49] a few inches to several feet of gray shale locally separates the limestone from the black shale (geol. secs. 31, 33).

*Distribution and outcrops.*—The limestone occurs in the southwest part of the Ottawa quadrangle and the northwest part of the Streator quadrangle. It is not recorded in records of borings near Streator. The best outcrops occur in Illinois Canyon (Starved Rock State Park) and near Vermilionville in the Ottawa quadrangle, and along Vermilion River in its lower two miles in the Streator quadrangle (geol. secs. 11, 12).

*Lithology.*—The limestone occurs as large septarian concretions (fig. 47), as sharply tapering lenses, and as a more or less continuous single bed. It has a maximum thickness of about 3 feet, is dark gray, dense, and very fine-grained, and breaks with a conchoidal fracture. Veins of brown calcite cut through the limestone more or less regularly and divide it into angular blocks. The limestone is usually argillaceous and at many places grades into the surrounding shale. A sample from near Vermilionville was twelve per cent insoluble in hydrochloric acid, the residue consisting of clayey silt,

[48]Cady, G. H., Geology and mineral resources of the LaSalle and Hennepin quadrangles: Illinois Geol. Survey Bull. 37, p. 56, 1919.

[49]Cady, G. H., op. cit., p. 56.

Fig. 47.—Septarian limestone (Unit 7) in Liverpool cyclothem, from outcrop along Little Vermilion River north of LaSalle, NE. ¼ NW. ¼ NW. ¼ sec. 2, T. 33 N., R. 1 E. (LaSalle Twp.), LaSalle quadrangle, (geol. sec. 31).

pyrite crystals, minute mica flakes, and a few grains of sand.

*Fossils.*—Fossils are present but rare. Single specimens of *Mesolobus mesolobus* have been found in several localities.

*Correlation.*—The limestone is correlated with a bed of similar lithology which occurs at the base of the Oak Grove unit in western Illinois. Through numerous outcrops along Vermilion and Little Vermilion rivers it is traced to outcrops north of LaSalle in the NE. ¼ NW. ¼ NW. ¼ sec. 2, T. 33 N., R. 1 E. (LaSalle Twp.) LaSalle quadrangle (geol. sec. 31), where it is identified by its association with several other beds characteristic of the Liverpool cyclothem in western Illinois (fig. 49).

### *Shale* (*Unit 8*)

*Distribution and outcrops.*—The uppermost unit of the Liverpool cyclothem is a dark gray sandy shale (Unit 8, fig. 45) which overlies the limestone (Unit 7) or the black shale (Unit 6) where the limestone is absent. The shale crops out in the southwest part of the Ottawa quadrangle and the northwest part of the Streator quadrangle. It is present in borings at Streator and may underlie much of the Streator quadrangle. It is well exposed in Illinois Canyon and along Vermilion River near Lowell (geol. secs. 11, 12, 33). It has not been recognized east of Illinois Canyon.

*Thickness.*—The shale has a maximum thickness of about 15 feet a short distance west of Lowell but is 6 feet thick at Vermilionville and only 3 feet thick at Illinois Canyon, which is the easternmost outcrop in which it has been differentiated. The shale is 10 to 20 feet thick in borings at Streator.

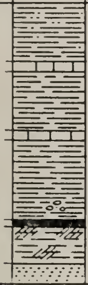
*Lithology.*—The shale is uniformly sandy, dark gray, finely micaceous, and thick-bedded. Lenses and concretions of dark gray limestone similar to that (Unit 7) at the base of the shale are present but do not occur at horizons which are identifiable from one outcrop to another. Some are a foot thick. No fossils have been found in the shale or limestone.

*Correlation.*—The failure to recognize the shale east of Illinois Canyon may be due to the fact that both the limestone (Unit 7) and black shale (Unit 6), which would serve to differentiate it from the underlying Francis Creek shale, are absent. It might therefore be equivalent to the upper sandy part of the Francis Creek shale in the area east of Illinois Canyon. This possibility is supported by the fact that where the Francis Creek shale is overlain by the black shale, it is relatively free from sand and silt. However, as there is no perceptible break between the non-sandy and sandy Francis Creek shale, as the Unit 8 shale is characteristically darker than the Francis Creek shale, and as the Unit 8 shale thins eastward, it appears more likely that the Unit 8 shale is absent, like the limestone and black shale.

## Lowell Cyclothem

The recent work in the Marseilles-Ottawa-Streator area has established the presence of a previously unrecognized cyclothem to which is applied the name Lowell for the town a short distance west of the northwest corner of the Streator quadrangle, in the vicinity of which it is well exposed. Equivalent beds in western Illinois have heretofore been included in the upper part of the Liverpool cyclothem. The type exposure (geol. sec. 33)[50] of the cyclothem occurs in the high bank on the south side of Vermilion River, SE. ¼ SW. ¼ sec. 8, T. 32 N., R. 2 E. (Vermilion

[50]The geologic sections are given in appendix A.



| Stratigraphic Unit Number | Section | Thickness | Material | Name |
|---|---|---|---|---|
| 16 | | 2′6″– 4′ | SHALE, GRAY, SANDY | |
| 15 | | 2″– 8″ | LIMESTONE, GRAY, SILTY | |
| 14 | | 6″– 6′ | SHALE, GRAY, GREEN, RED | |
| 13 | | 2″– 8″ | LIMESTONE, GRAY, FOSSILIFEROUS | |
| 12 | | 2′ – 6′ | SHALE, GRAY, GREEN, RED; DISCOIDAL IRONSTONE CONCRETIONS | |
| 11 | | 2″– 4″ | COAL OR BLACK SHALE | LOWELL |
| 10 | | 0 – 6″ | UNDERCLAY | |
| [illegible] | | 4′– 1′2″ | SILTSTONE | |

FIG. 48.—Generalized section of the Lowell cyclothem.

Twp.), LaSalle quadrangle, half a mile west of Lowell.

In northern Illinois the Lowell cyclothem is fully developed in a restricted area and is thinner than other cyclothems, but it contains eight stratigraphic units (fig. 48).

*Distribution and outcrops.*—The Lowell cyclothem underlies the southwest part of the Ottawa quadrangle and probably most of the Streator quadrangle. It crops out in several ravines near the east end of Starved Rock Park and along Vermilion River and its tributaries from Sandy Ford to Lowell. It is recognized in borings at Kangley and Streator (app. B, 1, 11-17) and also in LaSalle, Marshall and Woodford counties west of the Streator quadrangle (app. B, 41, 44, 49-54). A thin coal 20 to 30 feet above LaSalle (No. 2) coal recorded in borings at a few places in the east part of the Ottawa quadrangle and in the Marseilles quadrangle may be the Lowell coal.

*Thickness.*—The Lowell cyclothem is 21 feet thick in the type section but is thinner in the Ottawa and Streator quadrangles where the minimum observed thickness is 9 feet, two miles north of Wilsman (geol. sec. 13), and the maximum is 13 feet, southeast of Vermilionville (geol. sec. 12).

*Stratigraphic relations.*—The cyclothem is apparently conformable with beds both below and above. The basal siltstone (Unit 9) has a sharp contact with the underlying shale of the Liverpool cyclothem but the contact is uniformly even, and the top shales commonly grade into the overlying Pleasantview sandstone or siltstone, so that in many outcrops it is difficult to determine their separation exactly.

*Correlation.*—The Lowell cyclothem has been traced from outcrops in the Ottawa and Streator quadrangles to the type exposure at Lowell and also by outcrops along Vermilion and Little Vermilion Rivers to an outcrop on Little Vermilion River 1½ miles north of LaSalle (geol. sec. 31) where many of the typical beds of the western Illinois section are present (fig. 49). The siltstone, underclay, and coal of the Lowell cyclothem wedge into the Oak Grove unit of the Liverpool cyclothem as defined in western Illinois, and strata which in western Illinois are in the upper part of the Liverpool cyclothem are included in the Lowell cyclothem.

## STRATIGRAPHIC UNITS

### *Siltstone* (*Unit 9*)

The basal unit of the Lowell cyclothem is a gray finely micaceous slightly sandy siltstone (Unit 9, fig. 48) which is usually a single bed 4 to 8 inches thick, but at Illinois and Little Horseshoe canyons in Starved Rock State Park it consists of a foot of sandy gray shale with thin beds of siltstone (geol. secs. 9, 11-13, 31, 33). It is firmly cemented by calcite. A sample from the Lowell section was 30 per cent soluble in hydrochloric acid. In the Ottawa and Streator quadrangles the siltstone contains an abundance of plant impressions and streaks of charcoal, but along Little Vermilion River north of LaSalle it contains marine fossils. It is possibly equivalent to a calcareous sandstone that also contains marine fossils and

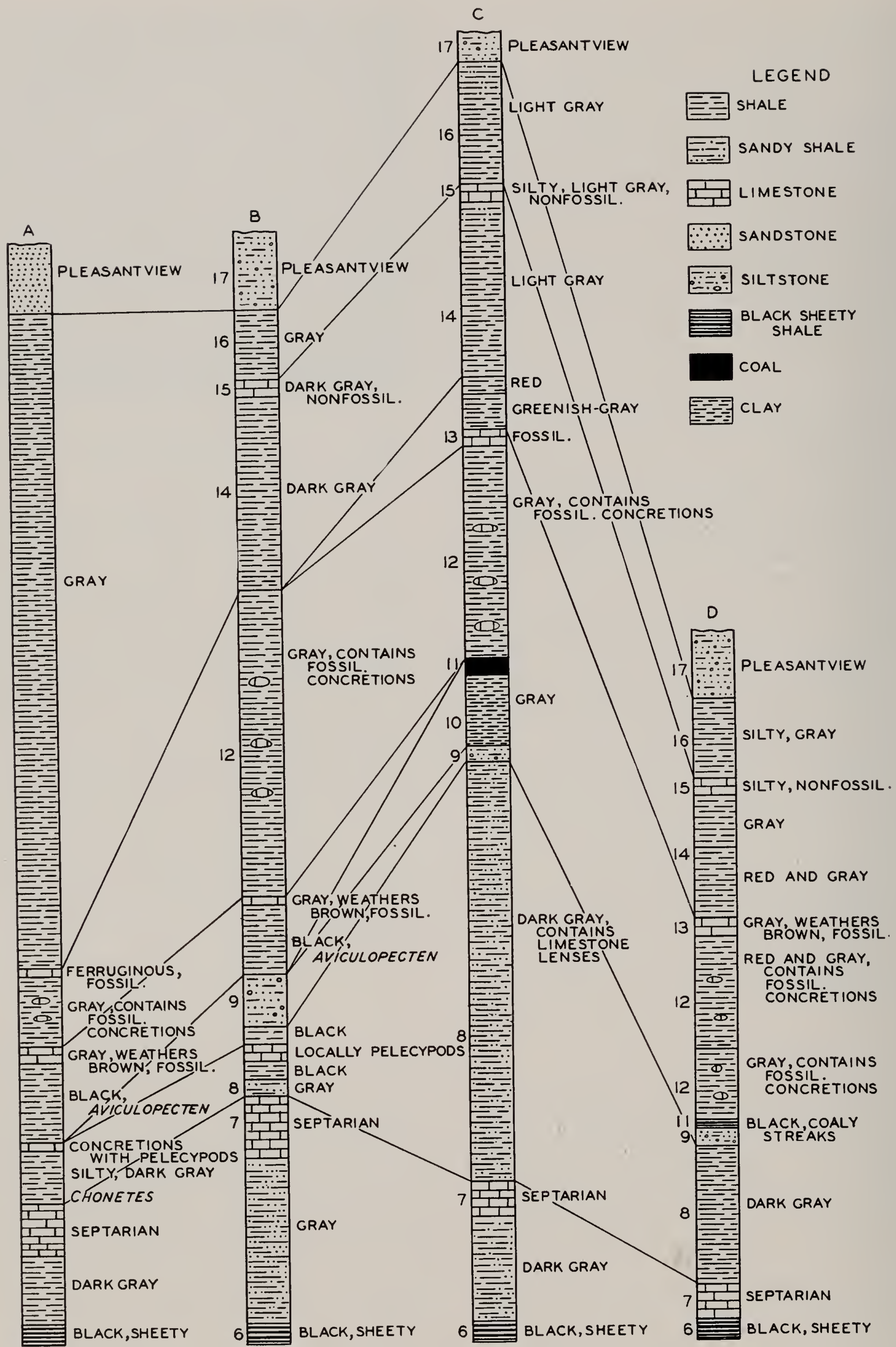



FIG. 49.—Graphic correlation of the beds between the black sheety shale of the Liverpool cyclothem and the Pleasantview sandstone of the Summum cyclothem in northern and western Illinois. The Lowell cyclothem consists of Units 9-16 inclusive.

A—Generalized section of western Illinois (after Wanless)
B—Geologic section 31, 1½ miles north of LaSalle
C—Geologic section 33, ½ mile west of Lowell
D—Geologic section 12, ½ mile southeast of Vermilionville.

that occurs in the Oak Grove unit in Adams, Scott, and Greene counties in western Illinois.[51]

### *Underclay* (*Unit 10*)

The clay below the Lowell coal, a typical light gray underclay (Unit 10, fig. 48), is exposed only in the vicinity of Lowell (geol. sec. 33) but is reported in a boring at Kangley (app. B, 14). It is only locally present even in the type exposure, where it reaches a maximum thickness of about 3 feet 6 inches. The upper 8 inches of the underclay is noncalcareous and the remainder calcareous.

### *Lowell coal* (*Unit 11*)

In the type exposure of the Lowell coal as much as 10 inches of shaly coal is locally present (geol. sec. 33). Farther east in outcrops in the Ottawa and Streator quadrangles it is represented only by a bed of black shale 2 to 4 inches thick with streaks of coal. It thickens southward and at Kangley 2 feet 9 inches of coal was reported in one boring (app. B, 12) and 2 feet 2 inches in another, but it was either absent or not recorded in several other borings. At Streator 1 foot, 2 feet 4 inches, 2 feet 6 inches, and 3 feet of coal is reported in borings and shaft records (app. B, 15, 16, 17). Near Maple Grove school east of Ottawa two borings report 1 foot and 1 foot 6 inches of coal 25 feet above the LaSalle (No. 2) coal and this may be the Lowell coal. The Lowell coal may be equivalent to the Bevier coal in Missouri and the Linton coal in Indiana.[52]

### *Shale* (*Unit 12*)

The Lowell coal is overlain by soft thin-bedded gray or mottled green and red non-gritty shale (Unit 12, fig. 48) which ranges in thickness from 6 feet at Lowell to 1 foot 8 inches along Little Horseshoe Canyon (geol. secs. 9, 11-14, 31, 33). Most of the beds in the shale are only ⅛ to 3/16 inches thick. Small "ironstone" concretions generally about 1 by 2 by 3 inches in size and oval in cross-section are common. Fossils occur rarely in the concretions, but the uppermost 2 inches of the shale is locally very fossiliferous with *Chonetes*, *Ambocoelia*, *Squamularia*, and horn corals most abundant.

The amount of red in the mottled red and green shale varies from a trace to more than half the unit. The contacts of the red and green areas are gradational through about 1 mm. Small areas of green shale are enclosed by red shale, and tapering areas of red shale, frequently centered around plant traces, penetrate the green shale. The red color appears to be secondary, resulting from the infiltration of iron oxide, and its distribution is controlled in part by small fractures or by plant traces which provided channels along which the solutions penetrated more readily.

### *Limestone* (*Unit 13*)

The lower of the two limestone beds (Unit 13, fig. 48) in the Lowell cyclothem is fine-grained, dense, and light to dark gray where fresh but weathers to a dark reddish-brown (geol. secs. 9, 12-14, 33) It usually forms a single bed from 2 to 8 inches thick but is locally nodular. In outcrops near Vermilion River it is very fossiliferous and has abundant *Marginifera muricatina* (app. G, table 2, No. 1 and pl. 30), but no fossils were found in it along Illinois and Little Horseshoe canyons.

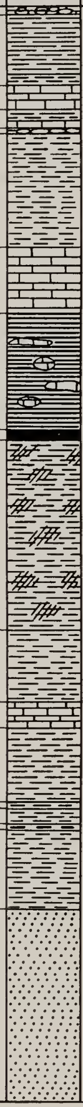
### *Shale* (*Unit 14*)

The shale (Unit 14, fig. 48) between the two limestone beds in the Lowell cyclothem is similar to Unit 12, being thin-bedded and variably gray to green locally mottled with red (geol. secs. 9, 11, 12, 14, 31, 33). It varies from 8 inches to 4 feet thick. Locally it is sandy near the top, and limestone concretions are locally present.

### *Limestone* (*Unit 15*)

A 2- to 8-inch single bed of light greenish-gray finely micaceous silty limestone (Unit 15, fig. 48) occurs near the top of the Lowell cyclothem in outcrops along Vermilion River but is absent in outcrops near Starved Rock State Park (geol. secs. 12-14, 31, 33). Locally it is a calcareous siltstone. Marine fossils are present but rare.

[51] Wanless, H. R., personal communication.
[52] Wanless, H. R., op. cit. p. 91.



| Stratigraphic Unit Number | Section | Thickness | Material | Name |
|---|---|---|---|---|
| 35 | | 0 - 4" | LIMESTONE CONGLOMERATE | COVEL |
| 34 | | 0 - 1'8" | SHALE, GRAY | |
| 33 | | 0 - 1' | CLAY, GREENISH-GRAY | |
| 32 | | 0 - 1' | LIMESTONE, GRAY | |
| 31 | | 0 - 10" | SHALE, CLAY, AND LIMESTONE | |
| 30 | | 0 - 4" | LIMESTONE CONGLOMERATE | |
| 29 | | 0 - 6' | CLAY, GREENISH-GRAY | |
| 28 | | 0 - 4' | LIMESTONE, GRAY | HANOVER |
| 27 | | 1' - 6' | SHALE, BLACK, LIMESTONE BANDS AND CONCRETIONS | |
| 26 | | 0 - 4" | COAL, BLACK SHALE | SUMMUM (NO.4) |
| 25 | | 2' - 8' | UNDERCLAY, GRAY | |
| 24 | | 0 - 3' | CLAY, LIGHT GREENISH-GRAY | |
| 23 | | 0 - 1' | LIMESTONE, GRAY, WEATHERS WHITE | |
| 22 | | 0 - 2' 6" | CLAY, LIGHT GREENISH-GRAY, DARK GRAY | |
| 21 | | 0 - 1/4" | CLAY, BLACK | |
| 20 | | 0 - 10" | CLAY, LIGHT GRAY, NEARLY WHITE | |
| 19 | | 0 - 1/2" | CLAY, BLACK | |
| 18 | | 0 - 2' 6" | CLAY, VARIEGATED | |
| 17 | | 1' 9" - 12' | SILTSTONE, VERY FINE-GRAINED SANDSTONE, SILTY LIMESTONE, AND SILTY SHALE, FINELY MICACEOUS | PLEASANTVIEW |

FIG. 50.—Generalized section of the Summum cyclothem.

*Shale* (*Unit 16*)

The uppermost member of the Lowell cyclothem is a thin-bedded finely micaceous gray sandy or silty shale (Unit 16, fig. 48), 2 feet 6 inches to 4 feet thick (geol. secs. 9, 11-14, 31, 33). At the top it grades into the overlying Pleasantview sandstone. In most outcrops it contains many small rough gray brown-weathering fine-grained silty limestone nodules.

## Summum Cyclothem[53]

The Summum cyclothem includes several distinctive members which, although thin, are widely distributed and remarkably uniform in character (figs. 50, 51). The uppermost unit is the Covel conglomerate, a thin bed which has been identified at many places across northern Illinois from Mazon River near Morris to Galesburg in western Illinois.

*Distribution and outcrops.*—The Summum cyclothem crops out frequently throughout the Marseilles-Ottawa-Streator area (pl. 11). In the Ottawa quadrangle the cyclothem is exposed along the lower four miles of Fox Valley and along Illinois Valley east of Twin Bluffs to Fox Valley on the north side and from Hennepin Canyon in Starved Rock State Park to one mile east of Ottawa on the south side. The entire cyclothem is exposed along Covel Creek south of Ottawa (fig. 52). In the Marseilles quadrangle it crops out in the Illinois valley-floor west of North Kickapoo Creek and also along O'Brien Run at the east margin of the quadrangle. In the Streator quadrangle outcrops are numerous along Vermilion River downstream from a mile south of Sandy Ford.

*Thickness.*—The Summum cyclothem is commonly between 20 and 25 feet thick, but it is as much as 27 feet thick along Covel Creek and is less than 20 feet thick along Vermilion River above Lowell, the minimum exposed thickness being 13 feet at Sandy Ford.

*Stratigraphic relations.*—The Summum cyclothem directly overlies the Lowell cyclothem where the latter is present and the Liverpool cyclothem where the Lowell cyclothem is absent or unrecognized. Despite this seeming overlap, it is apparently conformable with both, as its basal Pleasantview sandstone member seems to grade into the underlying uppermost sandy shales of both cyclothems. It is also apparently conformable with the overlying St. David cyclothem.

*Correlation.*—Several distinctive beds, especially the Covel conglomerate (Unit 35), enable the correlation of the strata in the Marseilles-Ottawa-Streator area with the Summum cyclothem in western Illinois. The Summum cyclothem has been traced[54] by outcrops from the type area to an exposure near Cambridge in Henry County (geol. sec. 34[55]), where the sequence is almost identical to that in the Marseilles-Ottawa-Streator area.

### STRATIGRAPHIC UNITS

*Pleasantview sandstone*[56] (*Unit 17*)

*Distribution and outcrops.*— The Pleasantview sandstone (Unit 17, fig. 50) is the basal unit of the Summum cyclothem (geol. secs. 3, 4, 7-9, 11-13, 30-33). It is usually well exposed because it is harder and more resistant than the adjacent shales and clays. Its numerous outcrops occur generally in the bluffs and ravines that intersect the base of the cyclothem (pl. 11), and it forms the rapids in Illinois River at Marseilles.

*Thickness.*—The exact top and bottom of the Pleasantview sandstone are usually difficult to determine, because the bottom grades from the top sandy shale (Unit 76) of the Lowell cyclothem or the sandy top of the Francis Creek shale (Unit 5) and the top grades into the overlying soft clay through a sandy zone locally as much as a foot thick. The thickness of the sandstone varies, being 1 foot 9 inches along Vermilion River at Sandy Ford, 2 to 2½ feet in the east part of Starved Rock State Park and vicinity and also along

[53]Wanless, H. R., Pennsylvanian cycles in western Illinois: Illinois Geol. Survey, Bull. 60, p. 182, 1931 .
Named for the town of Summum in southern Fulton County.

[54]Wanless, H. R., personal communication.

[55]The geologic sections are given in appendix A.

[56]Named for Pleasantview, Schuyler County, near which outcrops occur along Mill Creek. Searight, W. V., Illinois Geol. Survey, unpublished report on the Beardstown quadrangle.

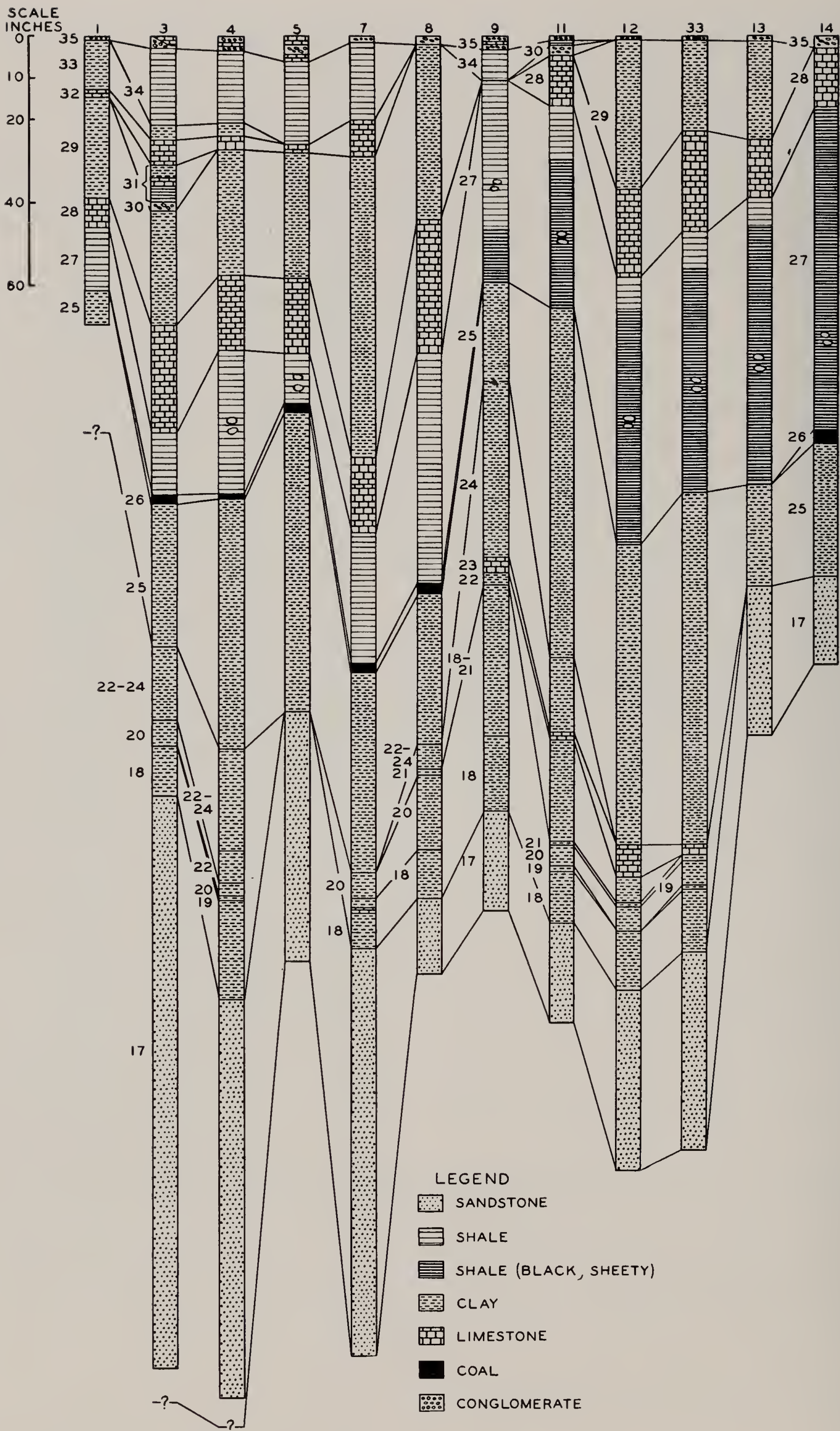



FIG. 51.—Graphic sections of the Summum cyclothem showing correlations and lateral variations of the stratigraphic units. The numbers at top of sections refer to geologic sections given in appendix A.


FIG. 52.—Pennsylvanian strata from the Francis Creek shale (Unit 5) to the Vermilionville sandstone (Unit 41) exposed along the north side of Covel Creek, NE. ¼ NW. ¼ NW. ¼ sec. 26, T. 33 N., R. 3 E. (South Ottawa Twp.), Ottawa quadrangle. (One-quarter mile downstream from geol. sec. 7.)

Fox Valley, 8 feet along Covel Creek, and 12 feet at Marseilles.

*Lithology.*—As shown by mechanical analyses of several samples (app. D, table 5, Nos. 3, 5-10), the Pleasantview sandstone is actually a calcareous sandy siltstone at many places in the Marseilles, Ottawa, and Streator quadrangles and the adjacent part of the LaSalle quadrangle. Locally, as at Dayton (sample 4), it is a silty limestone. Where the unit is less than 5 feet thick it is composed entirely of the siltstone but where it is thicker, as at Covel Creek and farther east, the siltstone forms an upper massive bed overlying very fine-grained sandstone (samples 1, 2). It is uniformly light gray or light greenish-gray but large rusty splotches, some an inch in diameter, which result from the weathering of pyrite, are especially abundant in the upper part of the bed.

Most of the sand grains are quartz but flakes of mica are abundant. The largest grains of quartz are about 0.25 mm. in diameter and mica flakes up to 0.5 mm. in diameter are common. The quartz grains are angular and show no evidences of rounding by abrasion. Some of the grains have been enlarged by the deposition of secondary quartz and have crystal faces.

The sandstone occurs in uniform beds ¼ inch to 2 feet thick. They are usually thicker in the upper part of the sandstone. Where thin the unit commonly consists of a single bed. The beds are nearly all parallel, and there is only a slight amount of cross-bedding and all at a low angle. Where the sandstone is well bedded the bedding-planes are rippled-marked, as along Covel Creek in the NE. ¼ SW. ¼ NE. ¼ sec. 26, T. 33 N., R. 3 E. (South Ottawa Twp.), Ottawa quadrangle.

*Correlation.*—The unit is correlated with the Pleasantview sandstone of western Illinois because of its stratigraphic position. East of the Marseilles quadrangle it is equivalent to a thick sandstone which is well exposed along Mazon River in the Morris quadrangle.[57]

[57]Culver, H. E., Geology and mineral resources of the Morris quadrangle: Illinois Geol. Survey Bull. 43B, p. 52, 1922. The sandstone which forms the upper part of Unit 2 of the generalized section is the Pleasantview sandstone.

STRATIGRAPHIC UNITS

### *Clay and limestone* (*Units 18-24*)

*Distribution and outcrops.*—A succession of several beds of clay differing in color and physical properties and including a thin bed of limestone (Units 18-24, figs. 50, 51) occurs above the Pleasantview sandstone and below the underclay of Summum (No. 4) coal. Many of the beds are persistent for miles, and correlations are possible between Lowell and Sulphur Springs, a distance of about 17 miles. These units crop out along Vermilion River and a tributary ravine near Lowell, in the ravines along the south side of Illinois Valley from Illinois Canyon to Covel Creek, along Fox Valley south of Sulphur Springs, and in Illinois Valley at Marseilles. The complete succession is well exposed along Illinois Canyon (geol. sec. 11) and in the ravine half a mile east of Little Horseshoe Canyon, SW. ¼ SW. ¼ NE. ¼ sec. 30, T. 33 N., R. 3 E. (South Ottawa Twp.), Ottawa quadrangle, but is lacking in outcrops along Vermilion River in the vicinity of Sandy Ford and along Fox Valley near Dayton.

*Thickness.*—The total thickness of the clay units is 5 to 8 feet in the ravines along the east side of Starved Rock State Park and for two miles east of the park, about 3 feet near Lowell, Covel Creek, and Marseilles, and 5 feet near Sulphur Springs.

*Lithology.*—*Unit 18*, the lowermost unit of the succession, is usually a variegated clay, 1 foot to 2 feet 6 inches thick, irregularly colored dark gray, dark greenish-gray, and purplish-gray (geol. secs. 3, 7, 9, 11, 12, 33). Locally it is all gray or greenish-gray. It is mostly noncalcareous but at places has calcareous bands with small limestone nodules. The basal few inches is usually sandy.

*Unit 19* is a thin streak of soft black clay, usually less than ½ inch thick, discontinuous in most outcrops, but present in the most widely separated outcrops of the sequence (geol. secs. 4, 11, 33).

*Unit 20* is a very light gray or nearly white clay, 5 to 10 inches thick, which is the most distinctive and probably the most persistent unit of the succession (geol. secs. 3, 4, 7, 11, 12, 33). It is more plastic than the other clays and is usually stained with limonite.

*Unit 21* is either a soft black clay about ¼ inch thick or, less commonly, several inches of dark gray clay (geol. secs. 11, 12, 33).

*Unit 22* is a clay variable in color and irregular in occurrence (geol. secs. 3, 4, 9, 11, 12). It has a maximum thickness of 2 feet 6 inches but is absent in several outcrops where other units of the succession are present. At some places it is all light greenish-gray calcareous clay with limestone nodules; at others it is a mixture of gray and light greenish-gray clay with thin black bands. It is best developed in the SE. ¼ NE. ¼ NW. ¼ sec. 32, T. 33 N., R. 3 E. (South Ottawa Twp.), Ottawa quadrangle.

*Unit 23* is a band of semilithographic gray to light gray white-weathering nonfossiliferous limestone nodules which at places form a continuous bed (geol. secs. 9, 11, 12, 33). It is uniformly present near Lowell, Vermilionville, and Illinois Canyon but has not been found north of Illinois Valley. It averages 6 inches and has a maximum thickness of 1 foot.

*Unit 24*, the top unit of the sequence, is a light greenish-gray calcareous clay which usually contains many small limestone nodules (geol. secs. 9, 11). It is present in Illinois Canyon and nearby ravines but has not been found near Lowell nor north of Illinois Valley. It varies from a trace to 3 feet thick.

*Correlation.*—In western Illinois a coal occurs very locally at approximately the position[58] of the black clay bands (Units 19 and 21) and may be equivalent to them. In the record of the Wenona shaft (app. B, 49) about two miles west of the Streator quadrangle, 1 foot 2 inches of coal is shown at this position.

### *Underclay* (*Unit 25*)

*Distribution and outcrops.*—The underclay of Summum (No. 4) coal (Unit 25, fig. 50) is more consistently present than the coal itself and crops out at many places along Illinois Valley near Marseilles and Ottawa, along Fox Valley near Dayton, and along Vermilion Valley below Sandy Ford (geol. secs. 3-5, 7-9, 11-14, 30, 33). It is reported in many borings in

[58]Wanless, H. R., personal communication.

the vicinity of Heenanville, Kangley, and Streator.

*Lithology.*—The underclay (fig. 53) is uniformly gray except that the upper 2 to 4 inches is usually slightly darker. It is usually between 4 and 6 feet thick but varies from 2 to 8 feet thick. It is calcareous except for a noncalcareous zone at the top varying from 6 inches to 2 feet 6 inches and averaging about 1 foot 6 inches thick, and small irregular limestone nodules are locally abundant in the calcareous part. It is usually slightly silty and locally the lower part is sandy. A sample from near Vermilionville (geol. sec. 12) contains 5 per cent of very fine angular grains of quartz sand. Small grains of pyrite are common in nearly all outcrops. The clay is nonrefractory (app. J, W-3).

*Fossils.*—Plant impressions occur in the clay at Sandy Ford (geol. sec. 14), and small fragments of coal are common at many places. Pyritic shells of *Spirorbis* and ostracods are present near Vermilionville.

### *Summum (No. 4) coal (Unit 26)*

*Distribution and outcrops.*—The Summum (No. 4) coal (Unit 26, fig. 50), which is usually shaly or has shale partings and at some places is represented by black shale with streaks of coal, crops out at many places in the west part of the Marseilles quadrangle and the east part of the Ottawa quadrangle, but is only locally present along Vermilion River between Lowell and Sandy Ford and is generally absent in Starved Rock State Park (geol. secs. 3-5, 7, 8, 14).

*Thickness.*—North and east of Covel Creek, coal No. 4 consists of thin lenticular streaks of bright coal or fusain in 1 to 2 inches of black shale, and locally a little "bone" coal is present. The coal is locally as much as 4 inches thick in outcrops along Vermilion River, but it is frequently absent. Farther south near Heenanville a boring and a shaft penetrated 1 foot 6 inches and 1 foot 3 inches of coal at this position (app. B, 1, 11). At Kangley the coal is reported to be 2 feet 6 inches thick in one boring (app. B, 12) but is either absent or logged as "slate" in other borings. At Streator

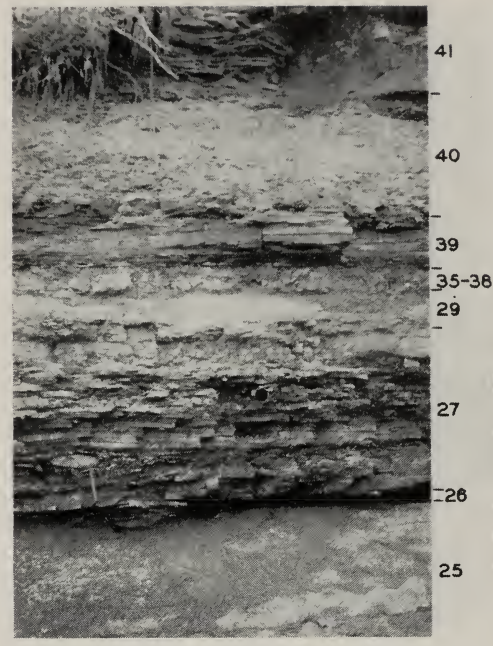



Fig. 53.—Outcrop showing all the strata from the underclay (Unit 25) of the Summum cyclothem to the Vermilionville sandstone (Unit 41) of the Brereton cyclothem, NW. ¼ NE. ¼ SE. ¼ sec. 15, T. 32 N., R. 2 E. (Deer Park Twp.), Streator quadrangle. The hammer head indicates a lenticular limestone concretion in the black shale of the Summum cyclothem.

2 feet 6 inches to 3 feet of coal is reported in several borings (app. B, 15, 17, 27, 31).

*Correlation.*—The correlation of this coal with the Summum (No. 4) coal of western Illinois is based on stratigraphic position. It is also present along Mazon Creek in the Morris quadrangle[59] where it is locally 2 feet thick.

### *Shale and slate (Unit 27)*

*Distribution and outcrops.*—The shale (Unit 27, figs. 50, 51) overlying the Summum (No. 4) coal occurs regularly in the Marseilles-Ottawa-Streator area and outcrops are numerous, especially in the southwest part of the Ottawa quadrangle and the northwest part of the Streator quadrangle where it is hard and more resistant to erosion than adjacent beds (geol. secs. 1, 3-5, 7-9, 11-14, 30, 32, 33).

*Thickness.*—The shale is thickest along Vermilion River in the northwest part of

[59] Bradley, F. H., Grundy County: Geological Survey of Illinois, vol. 4, p. 195, 1870.

the Streator quadrangle, where it is commonly between 4 and 6 feet, and thins to the east and north. It is 3 to 5 feet thick in the east part of Starved Rock State Park, 2½ to 3 feet thick along Covel Creek, 1 to 1½ and locally up to 3 feet thick along Fox Valley near Dayton and Sulphur Springs, and 1 to 1½ feet thick at Marseilles.

*Lithology.*—The unit consists of a series of black, gray, and green, soft and hard shales containing lenticular beds of siltstone and limestone and it might be subdivided into several thin units of variable character and limited extent. Along Vermilion River and its tributary ravines, the unit is predominately hard black shale. The basal 1-2 feet is usually black laminated sheety shale which grades upward to 1 to 4 feet of hard black shale with some dark gray bands. The upper shale occurs in ½- to 4-inch beds which are fractured at right angles to the bedding and weather into distinctive rectangular blocks. Lenses of dark gray siliceous limestone are locally present (fig. 53), and some of the fracture planes are filled with calcite or bluish-gray translucent chalcedony. Locally 6 to 8 inches of soft greenish-gray shale, or interbedded greenish-gray and black shale, is present at the top of the unit.

Along Illinois Canyon the shale is similar to that exposed along Vermilion River but more of it is gray, and lenses of siliceous limestone are more numerous. A lens of brownish-gray fine-grained siliceous limestone usually less than 6 inches but as much as 1 foot thick occurs at the base of the unit in and for about two miles east of Illinois Canyon.

Along Little Horseshoe Canyon, a mile northeast, the proportion of hard black shale is further decreased and the upper part of the unit consists of soft dark gray shale with beds of argillaceous limestone and locally lenses of gray silicified siltstone. A thin lenticular bed near the top is a speckled gray and black rock consisting of small interlocking and contorted lenses of gray argillaceous limestone and black calcareous shale. A somewhat similar rock a few inches lower is characterized by the presence of small black rods of limestone in a gray limestone matrix. Both of these beds are exposed at several places between Little Horseshoe Canyon and Sulphur Springs.

The easternmost outcrop of the hard black shale is in the north part of sec. 32, T. 33 N., R. 3 E. (South Ottawa Twp.), and east and north of Covel Creek the unit consists of soft thin-bedded shales which are greenish-gray or green, interbedded or mottled with black.

The unit characteristically contains spheroidal to ellipsoidal concretions or "niggerheads" of gray to dark gray very fine-grained dense limestone usually ½ to 1 foot but as much as 1½ feet thick (fig. 54). Many are elongated three or four times their thickness, with the largest dimensions parallel to the bedding of the shale.

*Fossils.*—Fossils are not common although *Orbiculoidea* and *Lingula* have been found. Conodonts are present in the basal black sheety shale but are rare. Plant impression occur in the basal limestone lens and in a thin band of limestone locally present near the top of the unit in and east of Illinois Canyon.

*Correlation.*—In western Illinois a black sheety shale or "slate" only locally occurs over coal No. 4, but concretions similar to those in northern Illinois occur in the soft greenish-gray to dark gray shale overlying the coal. The hard black shale is exposed in the south part of the LaSalle quadrangle (geol. sec. 33) and is recorded as "slate" in many borings in LaSalle, Marshall, and Woodford counties west of the Ottawa and Streator quadrangles (app. B, 40, 41, 48-51). East of the Marseilles quadrangle "slate" is reported in borings near Coal City (app. B, 39), but in outcrops along Mazon River and Waupecan Creek (geol. sec. 30), the unit is soft black shale.

### *Hanover limestone*[60] (*Unit 28*)

*Distribution and outcrops.*—The Hanover limestone (Unit 28, fig. 50) is uniformly present in the Marseilles-Ottawa-Streator area except along Little Horseshoe Canyon and in the NW. ¼ sec. 32,

[60]Named for Hanover school, east of Carrollton, Greene County, Illinois, near which it is exposed.

Van Pelt, J. R., Geology and mineral resources of the Roodhouse quadrangle: Illinois Geol. Survey, unpublished manuscript.

FIG. 54.—Concretions in Summum black shale (Unit 27) below the Hanover limestone (Unit 28) along the east side of Vermilion River at Sandy Ford, SW. ¼ SW. ¼ SE. ¼ sec. 32, T. 32 N., R. 3 E. (Farm Ridge Twp.), Streator quadrangle, (geol. sec. 14).


FIG. 55.—Brecciated Hanover limestone.

T. 33 N., R. 3 E. (South Ottawa Twp.), Ottawa quadrangle. It is well exposed along Illinois Valley near Marseilles, along Fox Valley south of Dayton, along Covel Creek, along Vermilion River near Sandy Ford, and elsewhere (geol. secs. 1, 3-5, 7, 8, 11-14, 32, 33[61]).

*Thickness.*—The average thickness of the limestone is probably between 1 and 1½ feet, but it is 2 feet in several localities, 3 feet along the ravine in the SW. ¼ NW. ¼ SW. ¼ sec. 27, T. 33 N., R. 3 E. (South Ottawa Twp.), Ottawa quadrangle, and reaches a maximum of 4 feet locally along the ravine in the SE. ¼ NE. ¼ SE. ¼ sec. 15, T. 32 N., R. 2 E. (Deer Park Twp.), Streator quadrangle. The variations in thickness appear to be complemented by inverse variations in the thickness of the overlying clay (Unit 29).

*Lithology.*—The limestone is light gray, light greenish-gray, or light brownish-gray. It usually weathers light gray or white but in many outcrops the upper part is stained with limonite.

The limestone is argillaceous with a variable content of light gray silty clay and usually contains a few small angular quartz sand grains and small crystals of pyrite. Eight samples averaged 23 per cent insoluble in hydrochloric acid, with extremes of 9 and 39 per cent. Locally the limestone grades vertically into the overlying clay or laterally to a row of nodules in clay. It usually forms a single bed (fig. 54) but locally the lower part is separated into several layers by discontinuous clay partings.

The limestone is very fine-grained and dense and breaks with a conchoidal fracture. It is distinctly brecciated (fig. 55) in several outcrops between Ottawa and Marseilles and at many other places it is faintly brecciated, especially in the upper 1 foot. At Marseilles (geol. sec. 3) it consists of angular fragments of light brownish-gray limestone in a matrix of light greenish-gray limestone which also penetrates the brownish rock in vein-like streaks. On fresh surfaces the materials are not markedly different but on weathered surfaces or on surfaces etched with acid the differences become apparent because the greenish-gray stone contains more clay that is left as a powdery residue.

At some places, as along O'Neill Branch in the SW. ¼ NW. ¼ SE. ¼ sec. 5, T. 33 N., R. 4 E. (Rutland Twp.), Ottawa quadrangle, many rough irregular black phosphatic nodules occur on the upper surface of the limestone (fig. 56). They are mostly less than 1 inch in diameter and the largest are about 2 inches.

Lenses of limestone with cone-in-cone structure from a trace to 3 inches thick are also common along the top of the unit in many localities.

[61]The geologic sections are given in appendix A.


FIG. 56.—Phosphatic nodules along the top of the Hanover limestone.

*Fossils.*—The limestone usually contains many fossils (app. G, table 2, Nos. 2, 3 and pl. 30), of which *Marginifera muricatina* greatly predominates in number of individuals, but fossils are less common where the limestone is brecciated.

*Correlation.*—The limestone is correlated with the Hanover limestone of western Illinois because it occurs at the same stratigraphic position between coals Nos. 4 and 5. It is also present in the LaSalle[62] (geol. sec. 33) and Morris quadrangles.

### *Clay* (*Unit 29*)

*Distribution and outcrops.*—The clay overlying the Hanover limestone (Unit 29, fig. 50) occurs irregularly over a wide area (geol. secs. 1, 3-5, 7, 8, 12, 13, 30, 33, 34). It is absent along Illinois Canyon and the ravines for two miles east, and along Vermilion River for about a mile both up and downstream from Sandy Ford.

*Thickness.*—The clay varies greatly in thickness both regionally and locally. It is 1 to 3 feet thick near Lowell and Vermilionville, 2 to 3 feet thick along Fox Valley and near Marseilles, and attains a maximum thickness of 4 to 6 feet along Covel Creek. Local variations in thickness apparently counterbalance variations in the thickness of the underlying Hanover limestone.

[62]Cady, G. H., op. cit. p. 57. The Hanover limestone is equivalent to the 1½ foot bed of fossiliferous impure limestone in the upper part of the section at Lowell.

*Lithology.*—The clay is light greenish-gray, gritty, and very calcareous. It contains, and at some places is crowded with, small irregular nodules of fine-grained gray limestone. Locally the lower part of the clay is faintly bedded. On weathered surfaces it fractures into large angular fragments, similar to but much larger than the fracture fragments of underclays.

*Fossils.*—Fossils are usually rare but in a few places the clay as well as the nodules in the clay contain many fossils, mostly *Marginifera muricatina.*

*Correlation.*—The clay is probably equivalent to a gray clay which locally underlies Covel conglomerate in western Illinois (geol. sec. 34).

### *Limestone conglomerate* (*Unit 30*)

A lenticular limestone conglomerate (Unit 30, fig. 50) with a maximum thickness of 4 inches occurs locally at Marseilles and along Illinois Canyon (geol. secs. 3, 11). It is well exposed for about a quarter of a mile along both sides of the Illinois Waterway canal at the highway bridge south of Marseilles and also along the south side of Illinois River about 100 yards downstream from the bridge.

The conglomerate is composed mostly of grains of fine-grained light gray to dark gray limestone less than ¼ inch in diameter but contains many pebbles up to ¾ inch in diameter, rarely larger. The matrix consists of light gray limestone, clear calcite, pyrite, and a few fine grains of quartz.

The conglomerate is identical in character with the widespread Covel conglomerate (Unit 35) which occurs a little higher stratigraphically, at the top of the Summum cyclothem.

Although it has been found only in the two localities in the Marseilles-Ottawa-Streator area, it is well developed at Cambridge in Henry County (geol. sec. 34). In areas where Units 31 to 34 are absent this bed may be included with or may replace the Covel conglomerate.

### *Shale, clay, and limestone* (*Unit 31*)

At the highway bridge across Illinois River at Marseilles (geol. sec. 3) the lower limestone conglomerate (Unit 30) and a limestone bed (Unit 32) are separated by 8 to 10 inches of shale, limestone, and clay (Unit 31, fig. 50). The basal part of the unit is 4 inches of dark gray thin-bedded shale, the middle part is a 1- to 3-inch conglomerate-like bed of gray fine-grained limestone nodules closely spaced in clay, and the top is 3 inches of dark greenish-gray clay similar to that in Unit 29. These beds might be considered as three units but because they have been found only at Marseilles they are grouped in a single unit.

### *Limestone* (*Unit 32*)

*Distribution and outcrops.*—An argillaceous limestone (Unit 32, fig. 50) less than 3 inches to 1 foot thick is present in nearly all outcrops of the Summum cyclothem north and east of Covel Creek, but it does not occur in the Streator quadrangle or in the southwest part of the Ottawa quadrangle (geol. secs. 1, 3-5, 7).

*Thickness.*—The limestone is about 1 foot thick along Covel Creek, is commonly less than 3 inches but locally 6 inches thick along Fox Valley, and is 4 to 8 inches thick at Marseilles.

*Lithology.*—The limestone is faintly mottled gray to greenish-gray, is very fine-grained, and has a distinct conchoidal fracture. In a few outcrops it grades into a layer of nodules in clay. Locally the upper few inches of the limestone contains spheroidal grains of black limestone, mostly less than one-fourth inch in diameter, which at some places are so numerous as to form a conglomerate. Along Covel Creek this conglomerate forms sharply tapering lenses up to 3 inches thick at the top of the limestone. Locally the top of the bed consists of interfingering and criss-crossing ridges of finely crystalline clear calcite (fig. 57), as near Sulphur Springs (geol. sec. 4) and along Covel Creek in the SE. ¼ SE. ¼ SW. ¼ sec. 26, T. 33 N., R. 3 E. (South Ottawa Twp.), Ottawa quadrangle.

*Fossils.*—Marine fossils have not been found in this limestone, but the black limestone pebbles and the ridges of calcite may be algal in origin.

### *Clay* (*Unit 33*)

In outcrops east of Walbridge Creek in the Marseilles quadrangle and along Fox River near Sulphur Lick Springs in the Ottawa quadrangle (geol. secs. 1, 3, 4) the local limestone (Unit 32) is overlain by 4 inches to 1 foot of greenish-gray calcareous clay (Unit 33, fig. 50) identical in appearance to the clay (Unit 29) which usually underlies the limestone.

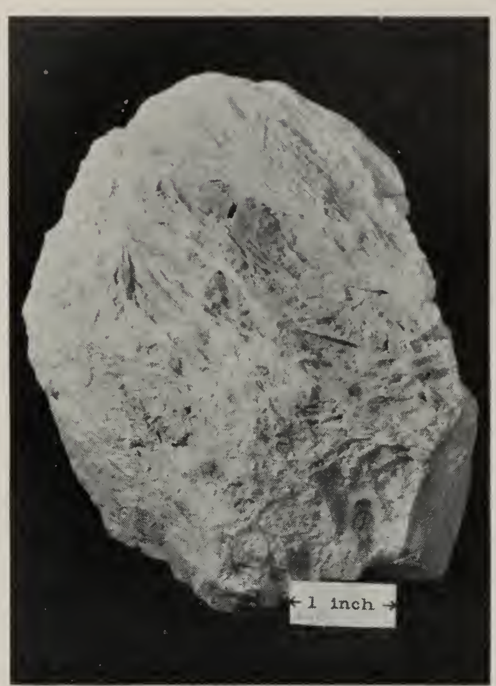



Fig. 57.—Algal structure of limestone (Unit 32) in the Summum cyclothem.

### *Shale* (*Unit 34*)

*Distribution and outcrops.*—The uppermost shale in the Summum cyclothem (Unit 34, fig. 50) occurs along Illinois Valley from Little Horseshoe Canyon east to Marseilles, along Fox Valley near Dayton and Sulphur Springs, and in secs. 15 and 22, T. 32 N., R. 2 E. (Deer Park Twp.), Streator quadrangle, but is locally missing between Little Horseshoe Canyon and Covel Creek (geol. secs. 3-5, 7, 9, 11).

*Thickness.*—The shale is commonly 1 to 1½ feet thick, except west of Covel Creek and in the northwest part of the Streator quadrangle where it is not more than 6 inches thick, and locally along Covel Creek and near Dayton where it is 1 foot 8 inches thick.

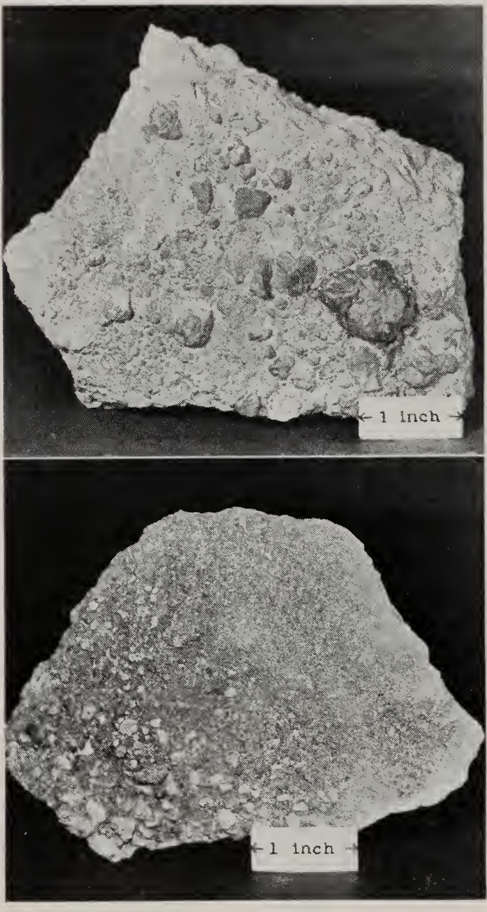



Fig. 58.—Views of top surface of Covel conglomerate showing: Top, poorly sorted conglomerate; and bottom, unusual lateral variation in grain size.

*Lithology*.—The shale is soft, calcareous, slightly silty, rarely sandy, and very micaceous and varies from light to medium gray. It is very thin-bedded although locally the bedding-planes are indistinct. Small crystals of pyrite and siderite are common, and the mica occurs in flakes up to 0.5 mm. in size. Fragmentary plant fossils are present near Sulphur Springs.

*Covel Conglomerate*[63] (*Unit 35*)

*Distribution and outcrops*.—The uppermost unit of the Summum cyclothem is the Covel conglomerate (Unit 35, fig. 50), a unique bed of limestone conglomerate. It is unlike any other bed in the Pennsylvanian system in northern Illinois except for the lenticular bed (Unit 30) which occurs locally a few inches below. The conglomerate occurs along Illinois Valley between Morris and LaSalle and near Cambridge, Galesburg, Peoria, and Danville, but has not been found in the southern part of the State. In the Marseilles, Ottawa, and Streator quadrangles (geol. secs. 1, 3-5, 7-9, 11-14, 30, 32-34) the conglomerate is present in nearly every outcrop where it would be expected, but in many outcrops it is locally missing.

*Thickness*.—The conglomerate is commonly 1 to 2 inches thick, has a maximum thickness of about 4 inches, and in many areas is less than one inch thick.

*Lithology*.—The conglomerate consists of pebbles usually less than 2 inches in diameter in a matrix of grains of sand size with locally a small amount of silt and clay. At many places the sand-size grains predominate and the rock is coarse-grained sandstone. The conglomerate shows little sorting by grain size although it is distinctly coarser in some areas than others (fig. 58).

The pebbles are largely limestone and consist of several kinds of limestone differing in color, grain size, and impurities. The limestone varies from black to light gray, the very dark gray or black limestone usually predominating. Most of the pebbles contain little clay or silt but some are argillaceous. They are mostly very fine-grained and dense but a few pebbles are finely crystalline. Locally pebbles of calcareous shale and siltstone are present. Limestone pebbles which are similar on fresh surfaces often have distinctly different colors on weathered surfaces.

Most of the grains of sand size are also limestone like that in the pebbles, but locally, as near Sulphur Springs, Dayton, and Covel Creek, a few quartz grains are scattered irregularly through the conglomerate. The quartz grains between 1/5 and 1/2 mm. are rounded and frosted and look like St. Peter sand grains. Grains of glauconite are present at several places but are rare.

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[63]Named for Covel Creek, south of Ottawa, along which it is well exposed.

Willman, H. B., The Covel conglomerate, a guide bed in the Pennsylvanian of Northern Illinois: Illinois Acad. Sci. Trans., vol. 32, pp. 174-176, 1939. Reprinted in Illinois Geol. Survey Circular No. 60, pp. 8-10, 1940.

Most of the pebbles have irregular shapes with nodular protrusions and smooth and rounded surfaces. The smaller pebbles and most of the sand grains are well rounded and some are nearly spherical. Sharply-angular lath-shaped fragments are common and locally abundant. The long axes of all except a few lath-shaped pebbles are nearly parallel to the surface of the bed.

The spaces between the pebbles and sand grains are filled with finely crystalline pyrite, clear coarsely crystalline calcite, or fine-grained limestone. Locally the calcite forms a single crystal enclosing all the grains in sections an inch or more in diameter. Where limestone forms the matrix material the pebbles are often less closely packed, and locally such areas grade into limestone containing scattered pebbles.

*Associated strata.*—Lenses of medium to dark gray nonfossiliferous very fine-grained limestone are commonly associated with the conglomerate. The lenses are commonly 6 inches to one foot thick and 4 to 5 feet long, with a thin layer of conglomerate usually at the top but sometimes at the base. Locally the conglomerate occurs in one or more bands through the limestone lenses and as many as 6 bands of conglomerate occur in a lens near Sulphur Springs (geol. sec. 4).

Locally there are also large ellipsoidal limestone concretions or "niggerheads," some of which penetrate the shales overlying the conglomerate and arch the black sheety shale of the St. David cyclothem, as along Walbridge Creek north of the highway in SE. ¼ SW. ¼ sec. 11, T. 33 N., R. 4 E. (Rutland Twp.), Marseilles quadrangle, and especially along Waupecan Creek just east of the Marseilles quadrangle (geol. sec. 30).

Lenses of light to dark gray argillaceous limestone with cone-in-cone structure are also locally associated with the conglomerate, especially where other lenses of limestone occur (fig. 59).

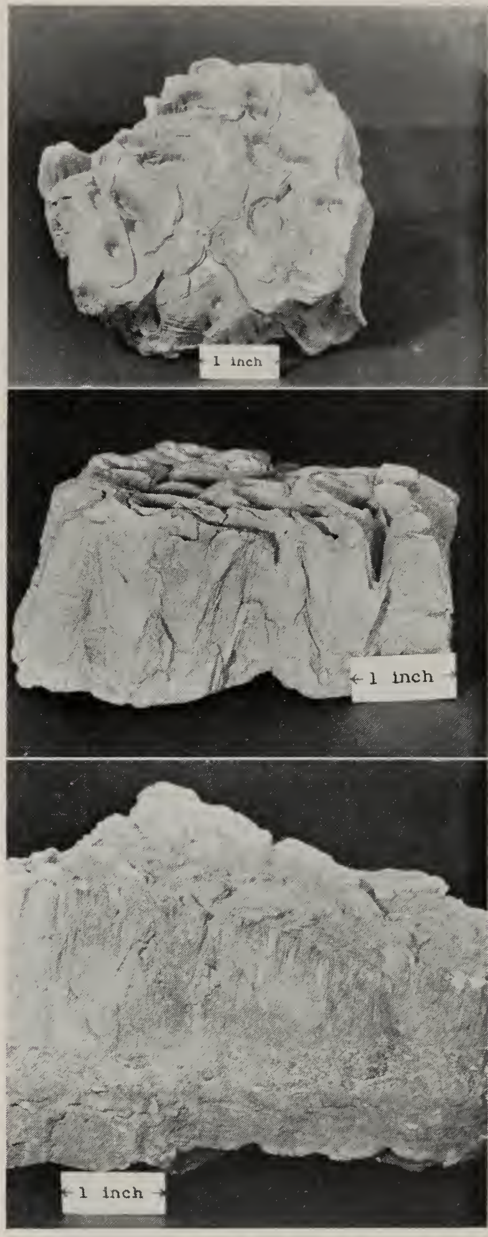


Fig. 59.—Cone-in-cone associated with Covel conglomerate: Bottom, cone-in-cone overlying the conglomerate; middle, sides of cones; top, tops of cones.

*Fossils.*—Fossils are usually rare in the conglomerate but are abundant at a few localities. Along the ravine in the SE. ¼ NE. ¼ SE. ¼ sec. 15, T. 32 N., R. 2 E. (Deer Park Twp.), Streator quadrangle, the conglomerate is composed largely of fossil debris (fig. 60). Crinoid stems are of general distribution and *Rhombopora* and *Marginifera muricatina* are locally common. *Lingula* and conodonts are present but rare. Minute shells of *Spirorbis* are


Fig. 60.—Covel conglomerate containing large amount of fossil debris.

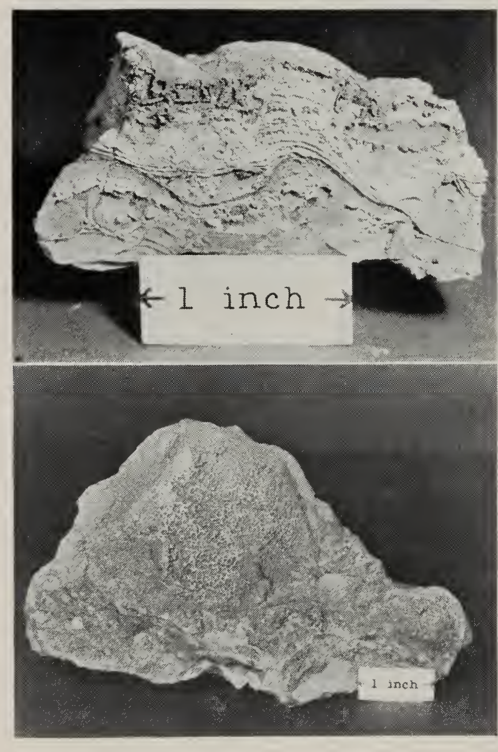


Fig. 61.—Algal growths on top of the Covel conglomerate: Top, etched surface showing banded character; bottom, pitted surface on top of algal structures.

locally present in great numbers, especially on the surface of algal growths.

The upper surface of the conglomerate is covered in some places by a peculiar pitted layer which is probably an algal growth (fig. 61). The layer consists of laminated calcite which at a maximum is about one inch thick, and locally is continuous over several square feet of the conglomerate, covering even the projecting pebbles. The upper surface is about equally divided into ridges and pits with the ridges about 1 to 2 mm. wide and 1 mm. high. The algal growths are well developed in outcrops along Illinois and Little Horseshoe canyons in the Ottawa quadrangle, and O'Brien Run, east of Seneca, in the SE. ¼ SW. ¼ SW. ¼ sec. 2, T. 33 N., R. 6 E. (Erienna Twp.), Marseilles quadrangle.

*Correlation.*—Because of its distinctive character, the Covel conglomerate has been recognized not only in northern but also in western Illinois. It is a valuable reference bed for correlation of strata both below and above it.

### St. David Cyclothem[64]

In northern Illinois the St. David cyclothem has no basal sandstone, underclay, and coal but some of its strata (fig. 62) are remarkably persistent and the black sheety shale is an important guide bed for correlation.

In the Marseilles-Ottawa-Streator area the cyclothem crops out at many places along Illinois Valley east of Buffalo Rock, along Fox Valley below Sulphur Springs, and along Vermilion Valley below Sandy Ford (pl. 11). It is generally 15 to 20 feet thick, but because of an unconformity at the top it varies from 2 to 65 feet thick.

It is apparently conformable with the underlying Summum cyclothem but it is overlain unconformably by the basal Vermilionville sandstone of the Brereton cyclothem (figs. 63, 67), which fills channels cut as deep as 60 feet in the Canton shale. If the greatest known thickness, about 65 feet, represents the original local thickness of the shale, at least 40 feet of it was eroded throughout most of the area before the sandstone was deposited.

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[64]Wanless, H. R., Pennsylvanian cycles in western Illinois: Illinois Geol. Survey Bull. 60, p. 182, 1931.
Named for the town of St. David in Fulton County.

| Stratigraphic Unit Number | Section | Thickness | Material | Name |
|---|---|---|---|---|
| 40 | | 6" - 65' | SHALE, GRAY; CONTAINS IRONSTONE CONCRETIONS NEAR BASE; ONE OR MORE THIN BEDS OF CANNELOID COAL OCCUR 8-12 FEET ABOVE BASE; UPPER PART SANDY | CANTON |
| 39 | | 9" - 2' | SHALE, BLACK, HARD, SHEETY | |
| 38 | | 1"- 4" | SHALE, BLACK, SOFT | |
| 37 | | 1"- 2" | SHALE, LIMEY, BLACK, HARD; CONTAINS WHITE FOSSILS | |
| 36 | | 2"- 10" | SHALE, DARK GRAY; ESTHERIA COMMON | |

FIG. 62.—Generalized section of the St. David cyclothem.

The correlation of these strata with the St. David cyclothem in western Illinois is based on their similar relation to the underlying Covel conglomerate and on the tracing of the strata by outcrops and well records. In western Illinois the St. David cyclothem has been traced as far northeast as Cambridge, in Henry County, where the sequence (geol. sec. 34)[65] is almost identical in many characteristics with that in the Marseilles-Ottawa-Streator area.

In western Illinois where the basal sandstone is generally lacking, the base of the cyclothem is placed at the base of the underclay of Springfield (No. 5) coal; but in northern Illinois where the sandstone, underclay, and coal are all lacking, it is placed at the base of a shale (Unit 36) believed to be equivalent to the underclay. This shale contains fossils of *Estheria*, a form believed to be indicative of brackish-water conditions. As it is overlain by strata with marine fossils, it is the only unit in the St. David cyclothem in northern Illinois which represents the nonmarine sandstone-to-coal sequence that forms the lower part of the cyclothems.

[65]The geologic sections are given in appendix A.

STRATIGRAPHIC UNITS

### *Shale* (*Unit 36*)

*Distribution, outcrops, and thickness.*—A shale (Unit 36, fig. 62) is uniformly present at the base of the St. David cyclothem in northern Illinois. It crops out at many places in the Marseilles-Ottawa-Streator area (geol. secs. 1, 3-5, 7-9, 11-14, 30, 32-34). It is 2 to 10 inches but usually 4 to 6 inches thick.

*Lithology.*—It is soft, dark gray or locally nearly black, calcareous, and occurs in beds mostly between ⅛ and ¼ inch thick. It contains an abundance of fine mica flakes mostly smaller than 0.1 mm., a small amount of fine silt, and many small fusain fragments, mostly smaller than 0.5 mm.

Lenses of limestone with cone-in-cone structure, usually less than ½ inch thick and up to 5 to 10 feet across, occur in about the middle of the shale at several places, as at Marseilles (geol. sec. 3) and Sulphur Springs (geol. sec. 4). They are usually parallel to the bedding of the shale but locally cut across the beds. Lenses of fine-grained dense gray limestone, 2 inches or less thick, occur at the same horizon as the cone-in-cone lenses.

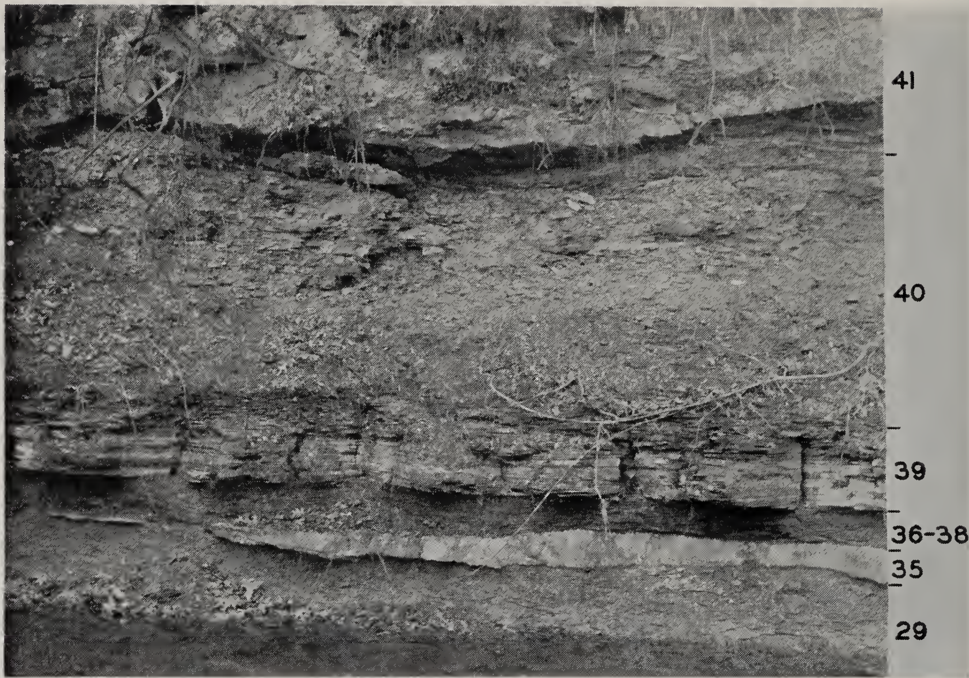



FIG. 63.—Outcrop showing entire section of the St. David cyclothem and the unconformable contact between the Canton shale and the Vermilionville sandstone along North Kickapoo Creek south of highway, SW. ¼ SE. ¼ NE. ¼ sec. 21, T. 33 N., R. 5 E. (Manlius Twp.), Marseilles quadrangle (geol. sec. 1).

*Fossils.*—At most places the shale contains an abundance of a small crustacean, *Estheria*, and pelecypods are present along O'Brien Run near the east side of Marseilles quadrangle, along the hard road at the north edge of Ottawa, and at the abandoned brick plant northwest of Ottawa. The fossils are mostly impressions in the soft shale and are fragile.

*Correlation.*—This shale is apparently equivalent to a calcareous clay which in western Illinois near Cambridge (geol. sec. 34) has about the same thickness and color and is bounded by the same characteristic beds. The clay at Cambridge is in turn correlated with the underclay of Springfield (No. 5) coal.

### *Shale (Unit 37)*

In northern Illinois the basal shale of the St. David cyclothem is regularly overlain by a bed of dark gray to black hard calcareous shale or locally argillaceous limestone (Unit 37, fig. 62), usually about an inch and rarely over 2 inches thick (geol. secs. 1, 3, 5, 7-9, 11-14, 30, 32-34). It is characterized by an abundance of white fossils, predominately *Marginifera muricatina*, but *Mesolobus mesolobus* is locally common (app. G, table 2, Nos. 4, 5, 6). The shells are usually badly crushed and poorly preserved.

### *Shale (Unit 38)*

The "white fossil" shale is regularly overlain in northern Illinois by soft thin-bedded black noncalcareous shale (Unit 38, fig. 62) which is usually about 2 inches but varies from 1 to 4 inches thick (geol. secs. 1, 3, 5, 7-9, 11-14, 30, 32-34).

### *Shale (Unit 39)*

*Distribution and outcrops.*—The hard black sheety shale (Unit 39, fig. 62) of the St. David cyclothem is uniformly present in the Marseilles-Ottawa-Streator area and is well exposed at many places along Illinois, Fox, and Vermilion valleys (geol. secs. 1, 3, 5, 7-9, 11-14), where it is conspicuous because it is much harder than the adjacent strata. It is reported in borings in the vicinity of Heenanville, Kangley, and Streator. It crops out also in the LaSalle[66] and Morris[67] quadrangles (geol. secs. 30, 32, 33).

*Thickness.*—It is usually 1 foot 3 inches to 1 foot 6 inches but varies from 9 inches to 2 feet thick.

*Lithology.*—The shale is a typical Pennsylvanian black sheety shale (p. 91, and figs. 53, 63, 64). It is crowded locally with gray limestone concretions, usually less than ½ inch in diameter, around which the beds of the shale bend. The concretions range from thin flat lentils to nearly spherical. In almost every outcrop the shale beds are broken into 1-2 foot rhombohedral blocks by two sets of parallel vertical joints which pass entirely through the shale (p. 188). Crystals of gypsum are abundant along many of the bedding-planes where the shale has been long exposed to weathering.

*Fossils.*—The shale is everywhere fossiliferous and is characterized by an abundance of *Aviculopecten rectilaterarius* in the lower 2 to 6 inches where they often cover almost every square inch of the surface of almost every bedding-plane. Scattered individuals occur locally in the upper part of the shale. Conodonts are common and *Lingula*, *Orbiculoidea*, and fish spines are present locally.

*Correlation.*—The black shale is continuous with that which overlies the Springfield (No. 5) coal throughout the State. The characteristic abundance of *Aviculopecten rectilaterarius* in the lower part of the shale continues across northern Illinois at least as far west as Cambridge, and although the fossil is common in the shale elsewhere in the State, it does not there occur in such concentrations and so does not serve to distinguish the shale from other black shales in which the same fossil is also locally present.

The shale can be traced in borings (app. B, 40-51) from outcrops along Vermilion River southwest to Sparland where borings show it underlies the exposed Brereton cyclothem.

In northern Illinois the abundance of

FIG. 64.—Black sheety shale (Unit 39) in the St. David cyclothem, exposed along Little Horseshoe Canyon, NE. ¼ NW. ¼ SW. ¼ sec. 30, T. 33 N., R. 3 E. (South Ottawa Twp.), Ottawa quadrangle.

*Aviculopecten* distinguishes this shale from all the other black sheety shales.

### *Canton shale*[68] (*Unit 40*)

*Distribution and outcrops.*—The Canton shale (Unit 40, fig. 62), which constitutes most of the St. David cyclothem in northern Illinois, is widely distributed throughout all three quadrangles (pl. 11). It crops out at many places along Illinois Valley and tributary ravines from the west side of Ottawa to a mile west of Seneca on the north side (fig. 63) and from Illinois Canyon to about two miles east of Ottawa on the south side, along the lower three miles of Fox Valley, along Covel Creek (figs. 52, 65) from the NW. ¼ sec. 27 to the SW. ¼ sec. 25, T. 33 N., R. 3 E. (South Ottawa Twp.), Ottawa quadrangle, and along Vermilion River (fig. 53) from near the northwest corner of the Streator quadrangle to about 1½ miles below Klein Bridge and again in a small area east of Klein Bridge in the SW. ¼ sec. 10, and the NW. ¼ sec. 15, T. 31 N., R. 3 E. (Bruce Twp.), Streator quadrangle, (geol. secs. 1, 3, 7-9, 12-14, 19, 30, 32, 33).

*Thickness.*—The Canton shale is 10 to 15 feet thick throughout a large part of the area but varies in thickness from 6 inches to 65 feet as a result of erosion

[66]Cady, G. H., Geology and mineral resources of the LaSalle and Hennepin quadrangles: Illinois Geol. Survey Bull. 37, 1919. (Uppermost black shale in section near Lowell, p. 57.)

[67]Culver, H. E., Geology and mineral resources of the Morris quadrangle: Illinois Geol. Survey Bull. 43B, 1922. (Bed No. 5 in the geologic section, p. 52.)

[68]Named for the town of Canton, in Fulton County, near which it has been used commercially. Savage, T. E., Geology and mineral resources of the Avon and Canton quadrangles: Illinois Geol. Survey Bull. 38B, pp. 36-37, 1921.

FIG. 65.—Canton shale (Unit 40) along Covel Creek, NW. ¼ NW. ¼ NW. ¼ sec. 36, T. 33 N., R. 3 E. (South Ottawa Twp.), Ottawa quadrangle. The canneloid coal lies just below the head of the hammer and may be distinguished by its blocky fracture.

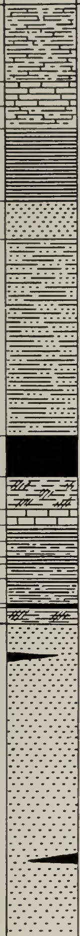
which cut in the shale deep channels that were later filled by the Vermilionville sandstone. The maximum thickness of shale is exposed along and near the north bluffs of Illinois Valley west of Marseilles in secs. 9, 10, 11, and 14, T. 33 N., R. 4 E. (Rutland Twp.), Marseilles and Ottawa quadrangles. Southeast of Ottawa in the NE. ¼ SW. ¼ sec. 18, T. 33 N., R. 4 E. (Fall River Twp.), Ottawa quadrangle, 25 to 30 feet of shale is exposed, and along Covel Creek in secs. 26, 35, and 36, T. 33 N., R. 3 E. (South Ottawa Twp.), Ottawa quadrangle, the shale is 30 to 35 feet thick. The shale is only 6 inches thick along the ravine in SE. ¼ NE. ¼ SE. ¼ sec. 16, T. 32 N., R. 2 E. (Vermilion Twp.), Streator quadrangle.

*Lithology*.—The lower 5-10 feet of the Canton shale is dark gray thin-bedded slightly silty shale which grades upward to 10-15 feet of gray medium-bedded slightly sandy shale, and where the shale is more than 20 feet thick the upper part is gray medium- and thick-bedded very sandy shale containing thin beds of silty sandstone. The beds are mostly ½ to 1 inch thick, and the shale fractures easily along the bedding-planes. The individual beds consist of laminae less than 1/16 inch thick, but the shale does not tend to part along the laminae any more readily than it fractures in other directions.

Discoid limonite-stained "ironstone" concretions of siderite with thin veins of calcite, mostly 1 to 3 inches in diameter, occur in several layers in the lower part of the shale, and locally, as along Walbridge Creek two miles west of Marseilles, they comprise almost continuous beds. Generally the concretions are most numerous and smallest in the darker thinner bedded shale near the bottom and are less common but larger higher in the shale.

Pyrite is present in small crystals, especially in the lower part of the shale. The upper sandy shale contains much mica in flakes as large as 0.2 mm., especially along bedding-planes.

At many places there is one and at one place there are two beds of canneloid coal or carbonaceous shale in the shale (fig. 65). The canneloid coal is blocky on fresh surfaces but weathers laminated, is uniformly very fine-grained, dull with greasy lustre, and lighter in weight than the shale. It grades into hard blocky black carbonaceous shale or into laminated shale. It has a maximum thickness of about 15 inches along the ravine in the NE. ¼ SW. ¼ sec. 18, T. 33 N., R. 4 E. (Fall River Twp.), Ottawa quadrangle, where it is split into sharply tapering lenses that cut irregularly through the shale. Along Covel Creek it is 3 to 6 inches thick, is uniformly parallel to the bedding of the shale, and lies 8 to 12 feet above the base. At Sandy Ford along Vermilion River (geol. sec. 14) it is 3 inches thick and occurs 11 feet above the base of the shale. East of Klein Bridge (geol. sec. 19) there are two thin beds of coal separated by 9 feet of shale. The canneloid coal has not been found north of Illinois Valley, but at a few places along the Illinois Valley bluffs in sections 9 and 10, T. 33 N., R. 4 E. (Rutland Twp.), Ottawa and Marseilles quadrangles, 5 feet of dark gray shale with



| Stratigraphic Unit Number | Section | Thickness | Material | Name |
|---|---|---|---|---|
| 57 | | 0-18′ | SHALE, GRAY, CALCAREOUS | |
| 56 | | 0-6′ | LIMESTONE, GRAY, ARGILLACEOUS OR NODULAR | BRERETON |
| 55 | | 0-7′ | SHALE, GREENISH-GRAY, CALCAREOUS | |
| 54 | | 0-14′ | SHALE, BLACK, HARD | |
| 53 | | 0-20′ | SANDSTONE | |
| 52 | | 0-58′ | SHALE, SILTY, SANDY | |
| 51 | | 3′-9′ | COAL; CONTAINS CLAY AND SHALE PARTINGS | HERRIN (NO. 6) |
| 50 | | 0-10′ | UNDERCLAY, GRAY | |
| 49 | | 0-4′ | LIMESTONE, GRAY, NODULAR, NON-FOSSILIFEROUS | |
| 48 | | 0-3′ | SHALE, BLACK, HARD | |
| 47 | | 0-2′8″ | SHALE, GRAY, SOFT | |
| 46 | | 0-1′4″ | SHALE, BLACK, HARD | |
| 45 | | 0-3′4″ | SHALE, GRAY, SOFT | |
| 44 | | 0-5′ | SHALE, GRAY TO BLACK, HARD AND SOFT | |
| 43 | | 0-2′ | COAL | |
| 42 | | 0-2′10″ | UNDERCLAY, GRAY | |
| 41 | | 15′-75′ | SANDSTONE, SILTY, GRAY, FINE-GRAINED, MICACEOUS; IN PART SANDY SHALE; CONTAINS THIN LOCAL COALS | VERMILIONVILLE |

Fig. 66.—Generalized section of the Brereton cyclothem.

bands of black laminated carbonaceous shale about 30 feet above the base of the shale may be equivalent to the coal.

The ceramic quality of the shale is shown by tests of sample W-1 (app. J).

*Fossils.*—Well-preserved fossils are locally abundant in the lower 5 feet of shale (app. G, table 2, Nos. 7, 8 and pl. 30). Many of the concretions are also fossiliferous. The fossils are predominately gastropods with *Phanerotrema grayvillensis* especially common.

*Correlation.*—The shale is lithologically similar to the Canton shale of western Illinois (geol. sec. 34), but is correlated with it on the basis of its stratigraphic relations to other distinctive units.

## Brereton Cyclothem[69]

The Brereton is the thickest and one of the most variable cyclothems in the area (fig. 66). Because many of the units are lenticular, not all of them are found in any one locality. Five units have been used commercially. The most important are the Herrin (No. 6) coal which has been the source of a large mining industry although in recent years the mining has been only local, and the shale overlying the coal which is used at several large plants manufacturing clay products. In addition a thin coal below coal No. 6 at

[69]Wanless, H. R., Pennsylvanian cycles in Western Illinois: Illinois Geol. Survey, Bulletin 60, p. 182, 1931. Named for the town of Brereton, in Fulton County.

Fig. 67.—Outcrop showing the undulatory contact of cross-bedded Vermilionville sandstone (at top) on the Canton shale along stream in SE. ¼ NE. ¼ SE. ¼ sec. 15, T. 32 N., R. 2 E. (Deer Park Twp.), Streator quadrangle. The hammer head rests on top of the black sheety shale (Unit 39) of the St. David cyclothem.

Streator has supplied coal for local use, the underclay of coal No. 6 has locally been used with the shale over the coal, and the Vermilionville sandstone has been used locally for building stone.

*Distribution and outcrops.*—The Brereton cyclothem is widely distributed in all three quadrangles (pl. 11), but in the Ottawa and Marseilles quadrangles it is represented only by the basal Vermilionville sandstone except in a small area at Marseilles where higher strata are present. The cyclothem does not occur north of Illinois Valley in the Ottawa quadrangle but in the south bluffs of the valley it crops out from near the mouth of Covel Creek to the east side of the quadrangle. In the Marseilles quadrangle the sandstone comprises all the bedrock exposed in the south bluffs of Illinois Valley and from Long Creek to O'Brien Run in the north bluffs. In the Streator quadrangle the cyclothem occurs at the top of the bluffs of Vermilion River in the northwest part of the quadrangle except where eroded along the preglacial channel northeast of Leonore. It gradually lowers upstream, so that except for a small area near Klein Bridge the bluffs are composed entirely of Brereton strata from one mile west of Klein Bridge to a mile above the waterworks dam southeast of Streator.

*Thickness.*—In the Streator quadrangle where the Brereton cyclothem is overlain by younger Pennsylvanian strata its thickness varies from about 45 feet near Klein Bridge to about 85 feet at Streator. In the Marseilles and Ottawa quadrangles the upper part has been eroded but the cyclothem has a maximum thickness of about 80 feet at Marseilles.

*Stratigraphic relations.*—The cyclothem rests unconformably on the St. David cyclothem and is overlain unconformably by the Sparland cyclothem. In most outcrops the contact of the Vermilionville sandstone with the underlying Canton shale is sharp and wavy (figs. 52, 63, 67) with a relief of 2 to 5 feet, but locally, as west of Marseilles between Walbridge Creek and Long Creek, the sandstone occupies steep-sided channels cut as much as 60 feet deep in the shale. The unconformable relations are well shown (1) along Gum Creek in the NE. ¼ NE. ¼ SE. ¼ sec. 18, T. 33 N., R. 5 E. (Manluis Twp.), Marseilles quadrangle, (2) along North Kickapoo Creek in the NE. ¼ SE. ¼ NE. ¼ sec. 21, T. 33 N., R. 5 E. (Manlius Twp.), Marseilles quadrangle, (3) along Covel Creek near the center NW. ¼ NW. ¼ sec. 26, T. 33 N.,

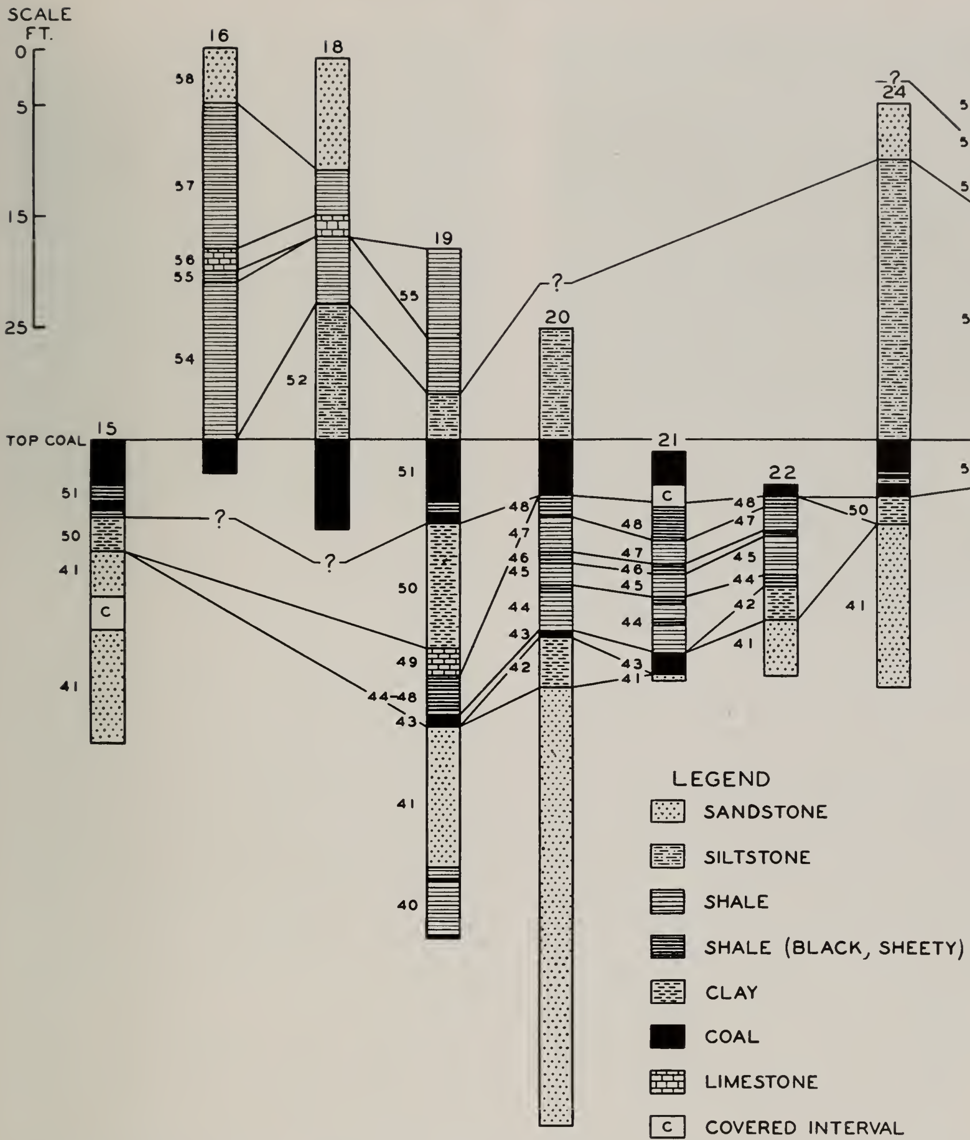



FIG. 68.—Graphs showing correlations and lateral variations of stratigraphic units of Brereton cyclothem in the Streator quadrangle.

R. 3 E. (South Ottawa Twp.), Ottawa quadrangle, and (4) along a ravine in the NW. ¼ NE. ¼ SE. ¼ sec. 15, T. 32 N., R. 2 E. (Deer Park Twp.), Streator quadrangle.

Unconformable relations also may exist within the cyclothem (fig. 68). The units (42-49) between the Vermilionville sandstone (Unit 41) and the underclay (Unit 50) of coal No. 6 occur only locally and appear to have been deposited in channels that extend from northeast to southwest in the top of the sandstone.

One such channel occurs in the vicinity of Klein Bridge, in the Streator quadrangle (geol. secs. 15, 19)[70]. A quarter of a mile east of the bridge there are 22 feet of strata between the top of the Vermilionville sandstone and the base of coal No. 6, and the sandstone is only

[70]The geologic sections are given in appendix A.

FIG. 69.—Thin-bedded Vermilionville sandstone in the east bluff of Vermilion River northwest of Streator, SE. ¼ SW. ¼ SW. ¼ sec. 23, T. 31 N., R. 3 E. (Bruce Twp.), Streator quadrangle.

10-15 feet thick, whereas about half a mile downstream and a quarter of a mile upstream, at the sides of the channel, the coal is only 2-3 feet above the sandstone and the sandstone is 40-50 feet thick.

The north side of another channel is exposed about two miles farther upstream and one-fourth mile south of the New York Central Railroad bridge across the river, where flat-lying beds of the Vermilionville sandstone (fig. 69) terminate against overlying strata that dip south at approximately 5 degrees, so that 25 to 30 feet of sandstone is cut out in about 150 feet. Coal No. 6 rests almost on the sandstone at the margin of the channel but is about 18 feet above the sandstone in the lower part of the channel. Because of the regional dip to the southeast the top of the sandstone passes below the river level southeast of Streator in the NW. ¼ sec. 2, T. 30 N., R. 3 E. (Reading Twp.), and consequently the south margin of the channel cannot be determined exactly but is north of the pit of the Purington Paving Brick Company in the NE. ¼ sec. 12, where coal No. 6 locally rests directly on the sandstone or is separated from it by only a few feet of underclay.

The "sags" in coal No. 6 over channels in the top of the sandstone probably account for its presence in a small area at Marseilles. In an outcrop in the bottom of the ravine in the SW. ¼ SE. ¼ NW. ¼ sec. 17, T. 33 N., R. 5 E. (Manlius Twp.), Marseilles quadrangle, the coal has a distinct dip to the east and is reported to be much higher in the ravine to the west. It is probably cut out by glacial drift to the east. As the Vermilionville sandstone exposed along the ravine and in the Illinois Valley bluffs about a mile south is flat-lying, the dip of the coal apparently reflects a depression in the top of the sandstone rather than a local synclinal structure which should affect all the beds. The channel at Klein Bridge trends toward Marseilles and it is conceivable that the two localities are in the same channel.

*Correlation.*—Outcrops along Vermilion River near Klein Bridge (geol. sec. 19) show that the Brereton cyclothem occurs above the Canton shale of the St. David cyclothem. In outcrops about two miles southeast of Streator it passes below the Sparland cyclothem (p. 136) which in turn is overlain by the more distinctive Gimlet cyclothem (p. 138). Its continuity with the Brereton cyclothem at LaSalle and Sparland is also shown by borings (app. B, 11, 12, 15, 17, 31, 40-53) and in these areas the cyclothem has distinctive characters that show its correlation with the type area. Although many of the individual units in the Marseilles-Ottawa-Streator area are similar to equivalent strata in the Brereton cyclothem elsewhere, none of their characters have been found to be distinctive, and they are correlated on the basis of stratigraphic position.

The strata thus included in the Brereton cyclothem (fig. 66) differ from those in the other cyclothems in consisting of many more units, several of which are not in the ideal cyclothem (fig. 42). In fact, the character and succession of the beds suggest that instead of one they may comprise three cyclothems, composed respectively of units 41-48, 49-52, and 53-57. These three groups each differ from an ideal cyclothem only in that in the lowermost the shales above the coal contain a brackish-water fauna rather than a marine fauna, in the middle group a basal sandstone and a limestone above the coal are lacking, and in the uppermost an underclay and coal are lacking. However, because the units (42-48) between the Vermilionville sandstone and the thick coal are known only in local channels in the

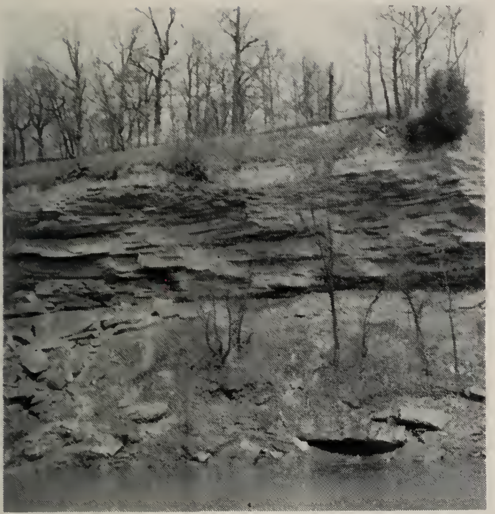


Fig. 70.—Bluff of Vermilionville sandstone along Vermilion River north of Sandy Ford, SW. ¼ SW. ¼ SE. ¼ sec. 32, T. 32 N., R. 3 E. (Farm Ridge Twp.), Streator quadrangle.

Fig. 71.—Thin-bedded sandstone with massive layers in upper part of the Vermilionville sandstone in road-cut, NW. ¼ NE. ¼ SW. ¼ sec. 23, T. 33 N., R. 4 E. (Fall River Twp.), Marseilles quadrangle.

sandstone, as shown by the study of outcrops in the LaSalle area and by borings in LaSalle, Marshall, and Woodford counties, it seems desirable not to consider them a distinct cyclothem unless they are found to be better developed elsewhere. Moreover, the upper shale and sandstone units (52-53) may be an unusual development of the shale (No. 6 in the ideal cyclothem, p. 87) that in some cyclothems occurs between the coal and the black shale or limestone, and it therefore seems desirable to consider them also as only local variations.

### STRATIGRAPHIC UNITS

#### *Vermilionville sandstone*[71] (*Unit 41*)

*Description and outcrops.*—Because of its superior hardness, the Vermilionville sandstone (Unit 41, fig. 66) is one of the most conspicuous of the Pennsylvanian beds, as it crops out frequently and forms high bluffs (fig. 70). It is the only unit of the Brereton cyclothem exposed along Illinois Valley in the Ottawa and Marseilles quadrangles (figs. 52, 63) except for a small area at Marseilles (p. 131), and in the Streator quadrangle it crops out at many places along Vermilion River and its tributaries downstream from the south side of Streator (figs. 53, 67).

*Thickness.*—The sandstone varies in thickness from 15 to 75 feet. The only outcrop in which the entire thickness of the sandstone is exposed is in the Streator quadrangle, a quarter of a mile east of Klein Bridge (geol. sec. 19), where the sandstone is only about 15 feet thick. Half a mile upstream it is more than 50 feet thick and a mile downstream it is more than 40 feet thick. In the north bluffs of Illinois Valley at Marseilles the total thickness of sandstone exposed is about 75 feet, but individual outcrops are usually less than 40 feet thick. High bluffs of sandstone also occur in the south valley-wall from Marseilles west nearly to Ottawa. The variations in thickness result partly from the sandstone filling deep channels in the underlying Canton shale and partly from the channel-like depressions in the top of the sandstone (p. 124).

*Lithology.*—The Vermilionville sandstone is usually light tan to light gray, fine-grained, highly micaceous, more or less carbonaceous, slightly calcareous, and

[71]Named for outcrops along Vermilion River near the village of Vermilionville (geol. sec. 33).
Cady, G. H., Coal resources of District I (Longwall): Illinois Geol. Survey, Coop. Mining Ser. Bull. 10, p. 29, 1915.

FIG. 72.—"Millstone" concretions in Vermilionville sandstone along Gum Creek, SE. ¼ SE. ¼ NE. ¼ sec. 18, T. 33 N., R. 5 E. (Manlius Twp.), Marseilles quadrangle.

silty and occurs in beds that range from very thin to massive beds as much as 6 feet thick (figs. 52, 67, 72). Thick beds are especially common in the lower part of the sandstone near Marseilles. Almost 50 feet of the formation exposed in a bluff half a mile upstream from Klein Bridge is largely thin-bedded. The upper part of the sandstone frequently consists of alternating thick- and thin-bedded strata (fig. 71). Cross-bedding is common and is well exposed along Long Creek west of Marseilles in the NE. ¼ SW. ¼ NW. ¼ sec. 13, T. 33 N., R. 4 E. (Rutland Twp.), Marseilles quadrangle, and along the ravine in the NW. ¼ NE. ¼ SE. ¼ sec. 15, T. 32 N., R. 2 E. (Deer Park Twp.), Streator quadrangle.

The thick-bedded sandstone is generally fine-grained, although some is very fine-grained (app. D, table 5, Nos. 11-36). Beds of sandy siltstone and sandy shale are common, especially in the thin-bedded sandstone.

The sandstone consists mainly of quartz grains, most of which are less than 0.3 mm. in size but a few are as large as 0.6 mm. Nearly all the grains are angular and most of them have several crystal faces resulting from the deposition of secondary silica. Some of the largest grains are subangular and slightly frosted.

The sandstone contains a large amount of mica, mostly muscovite and a little chlorite, in flakes up to 1 mm. in diameter, which almost solidly covers some of the bedding-planes and is scattered through the beds. Small crystals of pyrite are widespread. It weathers to limonite, and so the sandstone usually has many rusty-brown limonitic specks. Some beds of sandstone in nearly all outcrops are stained by limonite. Grains of feldspar are common. Tourmaline, zircon, and other heavy minerals are also common among the grains smaller than 100-mesh.

Fragmentary carbonaceous material is abundant. It is scattered irregularly throughout much of the massive stone, and in some thin-bedded parts of the sandstone it is so concentrated along nearly every bedding-plane that the rock appears dark gray or black.

Thin streaks and beds of coal are locally present, as in the lower 4 feet of the sandstone along North Kickapoo Creek, in the NE. ¼ SE. ¼ NE. ¼ sec. 21, T. 33 N., R. 5 E. (Manlius Twp.), Marseilles quadrangle. On the west side of Gum Creek in the north bluffs of Illinois Valley at Marseilles, a local lenticular bed of coal with a maximum thickness of 1 foot occurs from 2 to 3 feet above the base of the sandstone and is sharply bounded by sandstone both above and below. In the Streator quadrangle 1 to 6 inches of coal occurs near the top of the sandstone in outcrops along Vermilion River near the mouth of Eagle Creek.

Most of the sandstone is slightly calcareous but some parts are noncalcareous. Calcareous "millstone" concretions up to 5-6 feet in size are locally present, as along Gum Creek in the SE. ¼ SE. ¼ NE. ¼ sec. 18, T. 33 N., R. 5 E. (Manlius Twp.), Marseilles quadrangle (fig. 72).

*Fossils.*—The only fossils in the sandstone are fragmentary, poorly preserved, and fragile carbonaceous plant traces.

*Correlation.*—The Vermilionville sandstone occupies the same stratigraphic position as the Cuba sandstone in western Illinois and the Waupecan sandstone[72] of the Morris quadrangle.

### *Strata between Vermilionville sandstone and Herrin (No. 6) coal (Units 42-50)*

The Vermilionville sandstone and Herrin (No. 6) coal are normally separated by a typical light gray micaceous sandy underclay (Unit 50, fig. 66). It is from

[72]Culver, H. E., op. cit., p. 55.

a trace to 5 feet thick in the pit of the Purington Paving Brick Company south of Streator (geol. sec. 24), 3 feet thick along the south side of Vermilion River a quarter of a mile west of Klein Bridge (geol. sec. 15), and 1 foot thick along the ravine northeast of Marseilles in the SW. ¼ SE. ¼ NW. ¼ sec. 17, T. 33 N., R. 5 E. (Manlius Twp.), Marseilles quadrangle. Locally the underclay is absent and the coal rests directly on top of the sandstone.

A variable succession of strata between the top of the Vermilionville sandstone and coal No. 6 is exposed in two areas along Vermilion River—one near Klein Bridge and the other at Streator. Several alternative correlations of the strata in the two areas are possible. The one involving the fewest changes in character of the strata has been adopted and the units have been numbered accordingly (fig. 68). Because of the lithologic differences and the uncertainty of the correlations, the sequences in the two areas are described separately.

#### KLEIN BRIDGE AREA

The Klein Bridge area includes outcrops (geol. secs. 15-19)[73] in the Vermilion River bluffs and tributary valleys for about half a mile both up and down the valley from Klein Bridge (fig. 73).

*Coal* (*Unit 43*).—A bed of bony or shaly coal (Unit 43) grading into carbonaceous shale locally overlies the Vermilionville sandstone in the Vermilion River bluffs a quarter of a mile east of Klein Bridge (geol. sec. 19). Its thickness ranges up to a maximum of 5 inches. The coal contains many plant impressions.

*Shale* (*Units 44-48*).—The coal is overlain in the same outcrop by 4 feet of hard partly sheety black carbonaceous shale which is probably equivalent to part or all of units 44-48 at Streator. Thin streaks of coal and carbonized plant fossils are common in it.

*Limestone* (*Unit 49*).—The black shale is overlain by argillaceous very fine-grained light to dark gray nonfossiliferous limestone in irregular rough-surfaced nodular nonbedded masses of variable size that form a lenticular bed locally 4 feet thick. The limestone masses contain vein-like streaks of gray and black clay and hard shale and are stained rusty-brown with limonite.

[73]The geologic sections are given in appendix A.

Fig. 73.—Strata from the shale (Unit 54) overlying Herrin (No. 6) coal down to the Vermilionville sandstone, along the north side of Vermilion River, one-fourth mile east of Klein bridge, NW. ¼ SW. ¼ SW. ¼ sec. 10, T. 31 N., R. 3 E. (Bruce Twp.), Streator quadrangle (geol. sec. 19).

*Underclay* (*Unit 50*).—The underclay (Unit 50) of coal No. 6 is 7 to 15 feet thick in the river bank east of Klein Bridge but only 3 feet thick in the ravine a quarter of a mile west of Klein Bridge. It is sandy, light gray, and finely micaceous. It is unusually sandy where it overlies Vermilionville sandstone. It is generally noncalcareous but east of Klein Bridge the lower part locally contains limestone concretions. Also east of the bridge a 3-foot zone of sandy clay, locally present about 4 feet below the top of the underclay, is impregnated with limonite and contains many gypsum crystals.

#### STREATOR AREA

The Streator area includes outcrops (geol. secs. 20-22) along Vermilion River and its tributary valleys between the New York Central Railroad bridge northwest of Streator and the LaSalle-Livingston county-line southwest of Streator.

*Underclay* (*Unit 42*).—In an outcrop along the east bank of Vermilion River, below a greenhouse near the center SW. ¼ SW. ¼ sec. 23, T. 31 N., R. 3 E. (Bruce Twp.), (geol. sec. 20), the basal

Fig. 74.—Local coal (Unit 43) in Brereton cyclothem, exposed in strip mine, SE. ¼ SE. ¼ sec. 22, T. 31 N., R. 3 E. (Eagle Twp)., Streator quadrangle.

unit of the strata overlying the Vermilionville sandstone is a light gray micaceous limonite-stained calcareous sandy underclay (Unit 42) 4½ feet thick. The upper few inches is dark gray and faintly laminated. The basal part of the underclay contains rough-surfaced dark gray brown-weathering limestone nodules with a maximum thickness of about 1 foot. The underclay is absent in outcrops a quarter of a mile south of the greenhouse but is 2 feet 10 inches thick, noncalcareous, and limonitic southwest of Streator, along the west bank of Vermilion River in the NE. ¼ SW. ¼ SW. ¼ sec. 35, T. 31 N., R. 3 E. (Eagle Twp.), (geol. sec. 22).

*Coal* (*Unit 43*).—The underclay is overlain by a thin coal (Unit 43). The coal is bright and free from bedded impurities except a few thin lenses of pyrite. It has a maximum thickness of about 2 feet 6 inches in a strip mine (fig. 74) on the west side of Vermilion River, near the mouth of Eagle Creek in the SE. ¼ SE. ¼ sec. 22, T. 31 N., R. 3 E. (Eagle Twp.), but thins out and is missing within a quarter of a mile south. A short distance north, in the outcrop near the greenhouse, it consists of 2 inches of coaly black shale and 4 inches of bright coal.

*Shale* (*Unit 44*).—The shale (Unit 44) directly overlying the coal varies from one outcrop to another. In the outcrop near the greenhouse it consists of 3 feet 5 inches of light gray soft shale with dark gray layers, overlain by 7 inches of dark gray hard laminated shale. In an outcrop on the east side of Vermilion River, 200 yards north of the Chicago, Burlington and Quincy Railroad bridge (fig. 75 and geol. sec. 21), it consists of 5 feet of interbedded gray, dark gray, and black thin-bedded shale, and in the same outcrop some of the beds grade from hard partly sheety shale to much softer shale. In this exposure it contains large numbers of *Leaia* and *Estheria*. Southwest of Streator (geol. sec. 22) it consists of one foot of moderately hard interbedded dark gray and black shale.

*Shale* (*Unit 45*).—Unit 45 is a soft thin-bedded gray or greenish-gray shale, 1 foot 2 inches to 3 feet 4 inches thick, and contains layers of limonitic ironstone concretions. *Estheria* and *Leaia* are abundant in certain beds in the outcrop north of the railroad bridge.

*Shale* (*Unit 46*).—In the outcrop near the railroad, Unit 46 is a hard partly sheety black to dark gray shale containing *Estheria* and *Leaia* and is 8 to 16 inches thick, but southwest of Streator it is a moderately hard dark gray nearly black shale only 4 inches thick.

*Shale* (*Unit 47*).—Unit 47 is a gray or greenish-gray shale which is thin-bedded northwest of Streator but is only faintly bedded southwest of Streator. Locally it contains ironstone concretions. It varies from 2 feet to 2 feet 8 inches thick.

*Shale* (*Unit 48*).—A hard black sheety shale (Unit 48) which forms the floor of coal No. 6 at many places in the mines at Streator is exposed at several places along Vermilion River. The sheety character of the shale is not as well developed as in similar shales in the Liverpool and St. David cyclothems. The shale is very carbonaceous and at many places contains thin streaks of coal or charcoal. Plant impressions are common and *Estheria* and *Leaia* are locally abundant. The shale is about 1 foot thick southwest of Streator and 3 feet thick in outcrops near the mouth of Eagle Creek.

### *Herrin* (*No. 6*) *coal*[74] (*Unit 51*)

*Distribution and outcrops*.—The Herrin (No. 6) coal (Unit 51, fig. 66) is present

[74]Named for the town of Herrin, in Williamson County, where it has been mined extensively.
Shaw, E. W., and Savage, T. E., U. S. Geol. Survey, Geol. Atlas, Murphysboro-Herrin Folio (No. 185), p. 14, 1912.

in the central and southern part of the Streator quadrangle and in a small tract north and east of Marseilles (fig. 117). In the Streator quadrangle it crops out along Vermilion River in an area extending about half a mile each way from Klein Bridge, from the mouth of Eagle Creek upstream as far as the Santa Fe Railroad bridge south of Streator, and is also exposed in the shale pits a mile farther upstream. It has been mined from much of the area in the vicinity of Streator and Kangley.

In the Marseilles quadrangle coal No. 6 has been mined along the ravine northeast of Marseilles in the SW. ¼ NW. ¼ and the SW. ¼ sec. 17, T. 33 N., R. 5 E. (Manlius Twp.). The coal may also be present farther east in secs. 8-12, as wells penetrate as much as 3 feet of coal 100 to 155 feet above the LaSalle (No. 2) coal. However, this coal may also be only a local coal in the Vermilionville sandstone or the Canton shale. Coal No. 6 may be present locally in the south part of the Marseilles quadrangle, as a well in the NE. ¼ SE. ¼ sec. 27, T. 33 N., R. 6 E. (Norman Twp.), penetrated 1 foot of coal 125 feet above coal No. 2, and the coal is mined at Verona, two miles south of the southeast corner of the quadrangle, and was formerly mined along Waupecan Creek[75] about three miles east of the quadrangle in the SE. ¼ sec. 20, T. 33 N., R. 7 E. (Wauponsee Twp.), Morris quadrangle.

*Thickness.*—Coal No. 6 is more variable in thickness than the other coals in the area. In the large mines formerly operated at Streator it varied from 3 to 5 feet thick, averaging a little more than 4 feet thick. It appears to thin east, west, and south from Streator but is very thick in the Klein Bridge-Heenanville area. It is locally 9 feet thick in the vicinity of Heenanville School and 7 feet 2 inches thick in an outcrop a quarter of a mile east of Klein Bridge but is only 4 feet thick in a road-cut south of the bridge. In several outcrops the strata overlying the coal fill shallow channels or "rolls" in the top of the coal and locally these considerably reduce the thickness of the coal.

Fig. 75.—Outcrop of gray and black shales (Units 44-48) above the Vermilionville sandstone and below the Herrin (No. 6) coal on the east side of Vermilion River, SE. ¼ NW. ¼ NW. ¼ sec. 26, T. 31 N., R. 3 E. (Bruce Twp.), Streator quadrangle (geol. sec. 21).

Local variations in the thickness of the coal are apparently related to the attitude of the coal, which is rarely flat-lying but rises and falls in broad undulations 40 to 50 feet in amplitude. In the vicinity of Klein Bridge the coal varies as much as 50 feet in elevation in about 200 yards, and west and northwest of the Streator quadrangle borings show differences of about 40 feet in the thickness of the strata between coals No. 7 and No. 6, although the distance between coals No. 7 and No. 2 remains approximately uniform. Generally the coal is thicker in the depressions than on the elevations of the undulations, and although this is not always true, many of the exceptions may be the result of "rolls."

*Lithology.*—The coal bed consists of interbedded layers of bright and duller coal comprising respectively about one-third and two-thirds of the bed.[76] Bright coal bands are one-fourth inch or less thick. Thin layers of "mother coal" are common along the bedding-planes and are locally thick enough to make distinct partings. Generally the coal, especially the middle part, contains many persistent clay bands, as is well shown in the pit of the Purington Paving Brick Company

[75] Bradley, F. H., Geological Survey of Illinois, vol. 4, p. 194, 1870.

[76] Cady, G. H., Coal resources of District I: Illinois Geol. Survey, Coal Mining Inv. Bull. 10, p. 88, 1915.

Fig. 76.—Herrin (No. 6) coal in pit of Purington Paving Brick Co., south of Streator, NE. ¼ sec. 12, T. 30 N., R. 3 E. (Reading Twp.), Streator quadrangle (geol. sec. 24). (Illinois Geol. Survey Coop. Mining Series Bull. 10, p. 88, 1915).

south of Streator (geol. sec. 24 and fig. 76), but they are few in mines north of Streator.

The coal is commonly composed of three benches, of which the uppermost consists of 2 to 3 feet of coal usually without partings other than a thin layer of charcoal, the middle bench 1½ to 3 feet of interbedded clay, shale, and coal, and the lowermost 1 to 2½ feet of coal usually with few if any clay partings. The number and thickness of the clay bands in the middle bench vary considerably from place to place although they are usually persistent throughout individual mines. The lowest clay band in this bench is unusually thick and persistent.

*Correlation.*—In the vicinity of Streator this coal previously has been called the Streator (No. 7) coal[77] and was correlated with the "First Vein" coal at LaSalle. Because of its stratigraphic position with relation to other more distinctive beds, the abundance of many thin clay and shale bands, and the presence of the thick clay band 1-2 feet above the base, which may be the equivalent of the "blue band" characteristic of coal No. 6 in its type area, it is now correlated with the "Second Vein" coal at LaSalle, the Sheffield (No. 6) coal and the Brereton (No. 6) coal of western Illinois, and the Herrin (No. 6) coal of southern Illinois.

### *Shale (Unit 52)*

*Distribution and outcrops.*—The unusually silty shale (Unit 52, fig. 66) overlying coal No. 6 has been extensively used in the manufacture of clay products at Streator. It is well exposed in the shale pits and also along Vermilion Valley from the New York Central Railroad bridge northwest of Streator upstream to about

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[77]Worthen, A. H., Geological Survey of Illinois, vol. 7, p. 43, 1883.
Cady, G. H., op. cit., p. 39.

a mile above the waterworks dam southeast of Streator (geol. secs. 20, 24-26). Near Klein Bridge it is exposed in a strip mine northeast of the bridge and in an outcrop a quarter of a mile east of the bridge (geol. secs. 18, 19). It overlies coal No. 6 along the ravine northeast of Marseilles in the SW. ¼ SE. ¼ NW. ¼ sec. 17, T. 33 N., R. 5 E. (Manlius Twp.), Marseilles quadrangle.

*Thickness.*—Near Streator the shale is 20 to 40 feet thick in outcrops, and several borings (app. B, 15, 21, 31) encountered 50 to 60 feet of shale. Near Marseilles it is 5 feet thick, but the top has been eroded so that its entire thickness is not known. In the Klein Bridge area the maximum thickness exposed is 12 feet and occurs in a strip mine a short distance northeast of the bridge. In the outcrop a quarter of a mile east of the bridge the shale occurs only as a local lens with a maximum thickness of 7 feet.

*Lithology.*—Near Streator the shale is silty, clayey, and sandy, medium to dark bluish-gray but weathering slightly lighter in color, and highly micaceous, especially along bedding-planes. A sieve analysis of a sample showed 65 per cent silt, 30 per cent clay, and 5 per cent sand. The amount of sand is variable but generally increases toward the top. In some of the pits the shale grades laterally to very fine-grained silty sandstone and in others it contains beds of sandstone. Most of the shale occurs in thick beds (fig. 77). Because of the unusually high percentage of silt and sand grains, the abundance of large mica flakes, and the thick bedding, this unit usually resembles a siltstone or sandstone more than a shale, but chemical analyses (app. H, table 1, 202, K-7, K-15) indicate it is only slightly lower in content of clay minerals than other Pennsylvanian shales. The ceramic properties of the shale (p. 250) are shown by tests of samples 25, K-15 (app. J).

At Klein Bridge the shale is finer grained than at Streator, varies from soft and pulverulent to hard with a blocky fracture, and contains a few marine fossils.

Northeast of Marseilles the unit is represented by medium gray silty shale containing plant fossils.

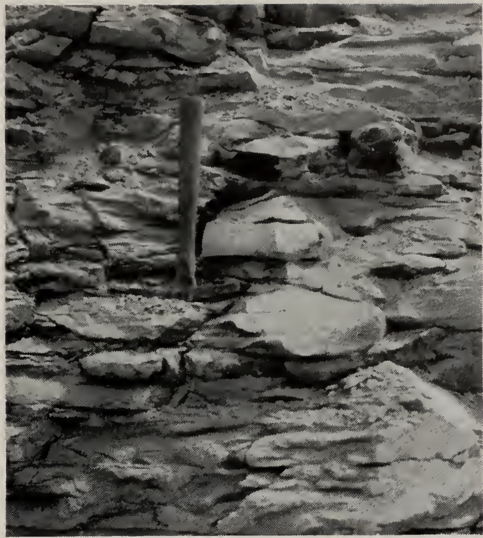

Fig. 77.—Shale (Unit 52) in pit of Streator Brick Co., NW. ¼ SE. ¼ sec. 35, T. 31 N., R. 3 E. (Bruce Twp.), Streator quadrangle.

*Correlation.*—A thick shale occurs between coal No. 6 and the Brereton limestone only locally in northern Illinois. Besides its occurrence in the Marseilles and Streator quadrangles, it crops out in the LaSalle quadrangle near Deer Park (geol. sec. 32) and borings show it present west of the Streator quadrangle (app. B, 54). It may be equivalent to a shale that overlies coal No. 6 in southern Illinois.

### *Sandstone (Unit 53)*

*Distribution and outcrops.*—Locally near Streator and LaSalle there is a sandstone (Unit 53, fig. 66) overlying the shale (Unit 52). It is exposed along Vermilion River south of Streator from the mouth of Moon Creek to a short distance above the waterworks dam southeast of Streator, especially (1) in the pits of the Purington Paving Brick Company and the Streator Clay Products Company, (2) in the bluffs of Vermilion River near the Atchison, Topeka and Santa Fe Railroad bridge, (3) below the waterworks dam, and (4) half a mile above the dam (fig. 78).

*Thickness.*—The sandstone is usually 3 to 10 feet thick but has a maximum thickness of about 20 feet. At many places the exact thickness of the sandstone cannot be readily determined because it is with

FIG. 78.—Sandstone (Unit 53) overlying shale (Unit 52) along the east bank of Vermilion River, SE. ¼ NE. ¼ SW. ¼ sec. 7, T. 30 N. R. 4 E. (Newtown Twp.), Streator quadrangle.

difficulty distinguished from the underlying shale.

*Lithology.*—The sandstone is silty, light gray, very fine- to fine-grained, micaceous, and usually slightly calcareous (app. D, table 5, No. 37). The sandstone occurs commonly in beds from 1 to 8 inches thick, any one bed being fairly uniform in thickness for considerable distances. At some places the sandstone appears to grade into the underlying shale and the contact is rarely sharp. At the southeast corner of the Streator Clay Products Company pit the sandstone appears to fill a channel cut into the underlying siltstone, as it increases in thickness from 5 to 20 feet in a horizontal distance of about 50 feet.

*Correlation.*—This sandstone may be only a locally developed phase of the underlying shale.

### *Shale* (*Unit 54*)

*Distribution and outcrops.*—A black shale (Unit 54, fig. 66) 5 to 14 feet thick overlies coal No. 6 in the vicinity of Kangley and Heenanville and is exposed near Klein Bridge (geol. secs. 16-19) but is not present at Streator.

*Lithology.*—The shale is mostly black, hard, and medium-bedded and has a blocky fracture, but commonly the upper few feet is soft and medium- to thin-bedded and grades both laterally and vertically through mottled gray and black to gray shale. Locally the lower 2 feet of the shale is thin-bedded and hard but it rarely has a sheety fracture comparable to that of the black shales in the Liverpool and St. David cyclothems. The shale contains lenticular dark gray limestone concretions, most of which occur in one or two discontinuous bands 1 to 3 feet above the base, but a few are scattered at other levels.

*Fossils.*—The shale is fossiliferous and pelecypods may be found in most outcrops.

*Correlation.*—The presence of a black shale or "slate" over coal No. 6 is common throughout the State.

### *Shale* (*Unit 55*)

At a few places south of Streator there is a light yellowish- or greenish-gray calcareous shale (Unit 55, fig. 66) below the Brereton limestone and above the sandstone, Unit 53. In the roadcut south of Vermilion River in the SW. ¼ SE. ¼ SE. ¼ sec. 2, T. 30 N., R. 3 E. (Reading Twp.), it is 7 feet thick and weathers light yellowish-brown. In the pit of the Streator Clay Products Company (geol. sec. 25) southeast of Streator it is 3 feet thick, light yellowish-gray or greenish-gray, thin-bedded, and calcareous. Farther south along Vermilion River it is 2 feet 8 inches thick, sandy, and light gray and greenish-gray and contains limestone concretions.

This shale (Unit 55) may be equivalent to the upper part of the black shale (Unit 54) which is locally gray, but the two units do not occur in the same areas and their relation is uncertain.

### *Brereton limestone* (*Unit 56*)

*Distribution and outcrops.*—The Brereton limestone (Unit 56, fig. 66) is exposed along Vermilion River and its tributary valleys for about half a mile above and below Klein Bridge and also locally south of Streator from the mouth of Moon Creek to nearly a mile above the waterworks dam (geol. secs. 16-18, 23, 25, 26).

*Thickness.*—In the Klein Bridge area the limestone varies from a trace to 4 feet thick. South of Streator it is commonly 3 to 4 feet thick, although it varies from 1 foot 8 inches to 6 feet thick, the maximum thickness occurring along the east side of the Streator Clay Products Company pit (geol. sec. 25).

*Lithology.*—In the Klein Bridge area the limestone is light gray where fresh, light yellowish-gray where weathered, very fine-grained and dense, variably soft to hard and brittle, and highly argillaceous, grading both laterally and vertically into calcareous shale. The limestone is brecciated, as shown faintly on fresh surfaces but distinctly when etched with acid, with thin veins of crystalline calcite separating the fragments. The limestone appears as a single ledge when freshly exposed but weathers into irregular beds 1-3 inches thick with thin shale partings. In some outcrops the exposed limestone has been leached, the residue forming argillaceous ocher in beds locally up to 8 inches thick, but the ocherous character probably does not extend far back from the outcrops.

In the area south of Streator the limestone is light to medium gray where fresh, irregularly light gray and buff where weathered, largely very fine-grained with irregular pockets fine- and medium-grained, and slightly argillaceous. It occurs in very irregular beds 1-6 inches thick separated by thin shale partings, and most weathered surfaces are distinctly knobby (fig. 79). In the road-cut on the east side of Moon Creek south of Streator (geol. sec. 23), the limestone is conglomeratic and contains many rounded fragments of dark gray or black limestone.

*Fossils.*—The limestone is usually very fossiliferous except where it is conglomeratic. In the outcrops near Klein Bridge it is characterized by an abundance of *Mesolobus mesolobus*. Near Streator the limestone contains a variety of fossils with *Squamularia perplexa* especially abundant (app. G, table 2, No. 10 and pl. 30). Crinoid stems about an inch in diameter are locally common. The fusulinids which are abundant in this limestone in western Illinois and are also present at LaSalle have not been found in the Streator area.

*Correlation.*—The limestone is correlated with the Brereton limestone of western Illinois and the Herrin limestone of southern Illinois by its stratigraphic position.

Fig. 79.—Brereton limestone exposed along north side of stream south of the Streator Clay Products Company's brick plant, NE. ¼ NW. ¼ NW. ¼ sec. 7, T. 30 N., R. 4 E. (Newtown Twp.), Streator quadrangle (geol. sec. 25).

### *Shale (Unit 57)*

In the Klein Bridge area the Brereton limestone is overlain by 4 to 18 feet of soft light yellowish-gray very calcareous shale (Unit 57, fig. 66), in beds mostly ½ to 2 inches thick (geol. secs. 16-18). The maximum thickness is exposed along a ravine on the south side of the river, 100 yards west of Klein Bridge. The shale contains many thin bands which are highly fossiliferous and some are crowded with excellent specimens of *Chonetes granulifer* and *Mesolobus mesolubus* (app. G, table 2, No. 9).

## MC LEANSBORO GROUP[78]

Of the cyclothems comprising the McLeansboro group, only the Sparland and Gimlet are exposed in the Marseilles-Ottawa-Streator area, but several higher ones probably underlie glacial drift in the southwest part of the Streator quadrangle. The total thickness of the exposed part of the group is only about 50 feet, but the total thickness of the group in the area where it is buried is probably much greater, as a shaft at Wenona (app. B, 49) two miles west of the quadrangle penetrated about 250 feet of McLeans-

[78]Named for the town of McLeansboro, Hamilton county, Illinois, near which a diamond-drill boring provided a good record of the upper "Coal Measures." De Wolf, F. W., Studies of Illinois coal, Introduction: Illinois Geol. Survey Bull. 16, p. 181, 1910.

boro strata. The McLeansboro and Carbondale strata are separated by the unconformity at the base of the Sparland cyclothem.

## Sparland Cyclothem[79]

In the Marseilles-Ottawa-Streator area the Sparland cyclothem is characterized by a thick underclay and by the absence of strata containing marine fossils (fig. 80). A small amount of coal for local use has been mined from the Sparland (No. 7) coal in the south part of the Streator quadrangle and the underclay has been used in the manufacture of clay products.

*Distribution and outcrops.*—The cyclothem occurs mainly along the west margin and in the south third of the Streator quadrangle (pl. 11). Outcrops occur in three small areas along Vermilion River: (1) near Klein Bridge, (2) about a mile above the waterworks dam southeast of Streator, and (3) about half a mile along the river at the south margin of the quadrangle.

*Thickness.*—The cyclothem is 15 to 30 feet thick in the outcrops but may be as much as 60 feet thick where buried in the southwest part of the quadrangle. Variations in thickness are caused principally by the unconformity at the top of the cyclothem.

*Stratigraphic relations.*—The contact of the cyclothem with the underlying Brereton cyclothem is poorly exposed near Streator but at LaSalle and Sparland it is unconformable.

The cyclothem is overlain unconformably by the sandstone at the base of the Gimlet cyclothem. In outcrops along Vermilion River the sandstone locally fills channels which cut through the Farmington shale and the Sparland (No. 7) coal. It is possible that a considerable thickness of shale has been eroded from most of the area, as the maximum exposed thickness is only 6 feet whereas in borings west of the area and in outcrops near LaSalle and Sparland the shale is commonly 20 to 40 feet thick.

*Correlation.*—The correlation with the type exposure near Sparland in western Illinois is based largely on its relation to distinctive units in the overlying Gimlet cyclothem and on records of borings in the intervening area. However, the individual units, as noted later, have several points of similarity with equivalent beds at LaSalle and Sparland.

### STRATIGRAPHIC UNITS

#### *Copperas Creek Sandstone* (*Unit 58*)[80]

*Distribution and outcrops.*—The Copperas Creek sandstone (Unit 58, fig. 80) crops out along Vermilion River in a small area near Klein Bridge and about a mile upstream from the waterworks dam southeast of Streator (geol. secs. 16, 18, 26, 27[81]). It probably underlies most of the southwest part of the Streator quadrangle.

*Lithology and thickness.*—Near Klein Bridge the sandstone is silty, light gray, micaceous, and calcareous. It is thin-bedded, and the beds are uniformly parallel. The maximum thickness exposed is 10 feet at the strip mine northeast of the bridge.

Southeast of Streator the sandstone is silty, light gray to nearly white, fine-grained, and micaceous. The beds are parallel and vary in thickness from ¼ inch to 1 foot 6 inches. At the only good outcrop of the sandstone, along the east side of Vermilion River in the SE. ¼ SE. ¼ SW. ¼ sec. 7, T. 30 N., R. 4 E. (Newtown Twp.), it is between 5 and 10 feet thick. The lower part of the sandstone is not well exposed, and the relation to the underlying strata is not clear. The Brereton limestone, which directly underlies the sandstone half a mile downstream on the west side of the valley, may be cut out at this locality, in which case the sandstone would overlie a lower sandstone (Unit 53) in the Brereton cyclothem.

*Correlation.*—The sandstone is correlated with the Copperas Creek sandstone of western Illinois solely on the basis of its stratigraphic position.

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[79]Wanless, H. R., Pennsylvanian cycles in western Illinois: Illinois Geol. Survey Bull. 60, p. 182, 1931.
Named for the town of Sparland, in Marshall County, north of which it crops out on Thenius Creek.

[80]Named for outcrops along Copperas Creek in Fulton County along which it is well exposed.
Wanless, H. R., Pennsylvanian correlations in the Eastern Interior and Appalachian coal fields: Geol. Soc. America, Special Paper 17, p. 80, 1939.

[81]The geologic sections are given in appendix A.

| Stratigraphic Unit Number | Section | Thickness | Material | Name |
|---|---|---|---|---|
| 61 | | 0 - 6′ | SHALE, GRAY; LOCALLY BLACK AT BASE | FARMINGTON |
| 60 | | 0 - 4′6″ | COAL | SPARLAND (NO. 7) |
| 59 | | 10′-11′ | UNDERCLAY, GRAY; CONTAINS LIMESTONE NODULES IN LOWER PART | |
| 58 | | 5′-10′ | SANDSTONE, SILTY, LIGHT GRAY, FINE-GRAINED, MICACEOUS | COPPERAS CREEK |

Fig. 80.—Generalized section of the Sparland cyclothem.

### *Underclay* (*Unit 59*)

*Distribution and outcrops.*—The underclay (Unit 59, fig. 80) of coal No. 7 occurs in the south part of the Streator quadrangle. It is exposed along Vermilion River about a mile above the waterworks dam in the south part of sec. 7 and the north part of sec. 18, T. 30 N., R. 4 E. (Newtown Twp.) (geol. sec. 27) and near the southern margin of the quadrangle in the south part of sec. 5 and the north part of sec. 8, T. 29 N., R. 4 E. (Amity Twp.) (geol. sec. 28).

*Thickness.*—The maximum thickness of underclay exposed is 10 feet in the west bank of Vermilion River about a mile above the waterworks dam (geol. sec. 27). This is the only place where the entire thickness is exposed. The clay is reported to be 10 to 11 feet thick in the area where it is mined at the mouth of the creek in the NW. ¼ NE. ¼ sec. 18, T. 30 N., R. 4 E. (Newtown Twp.). A boring (app. B, 32) in the bottomland in the NW. ¼ SE. ¼ SW. ¼ sec. 7 penetrated 8 feet of clay and did not reach the base. Two miles west a boring (app. B, 38) along Moon Creek in the SE. ¼ SE. ¼ SE. ¼ sec. 10, T. 30 N., R. 3 E. (Reading Twp.), penetrated 10 feet 4 inches of clay below coal No. 7. Along Vermilion River, near the south margin of the quadrangle (geol. sec. 28), 6 feet of underclay is exposed but the base is concealed in all outcrops in that area so the entire thickness is not known.

*Lithology.*—The clay is soft, plastic, slickensided, and mostly light gray, although the upper few inches is usually darker and the lower part is mottled with dark gray. Much limonite is present in most outcrops. At places the clay contains carbonaceous material and plant impressions. In the one outcrop where the complete unit is exposed (geol. sec. 27) the upper 6 feet is noncalcareous except for a slightly calcareous band 10 inches thick about 1 foot 8 inches from the top. The lower 4 feet is calcareous and contains many small rough-surfaced gray limestone nodules which weather green and red. The chemical composition of the underclay is shown by the analysis of sample 205 (app. H, table 1), and its ceramic properties by tests on the same sample (app. J).

*Correlation.*—A thick underclay is also present below coal No. 7 at LaSalle and Sparland and is recorded in many borings (app. B, 49, 54) a short distance west of the Streator quadrangle.

### *Sparland* (*No. 7*) *coal* (*Unit 60*)

*Distribution and outcrops.*—The Sparland (No. 7) coal (Unit 60, fig. 80) underlies the south part of the Streator quadrangle (fig. 117) and crops out along Vermilion River at several places in sec. 18, T. 30 N., R. 4 E. (Newtown Twp.), and near the south margin of the quadrangle in the south part of sec. 5 and the north part of sec. 8, T. 29 N., R. 4 E. (Amity Twp.) (geol. secs. 27, 28).

*Thickness and lithology.*—The coal is 2 to 3 feet thick in outcrops along Vermilion River in the NW. ¼ sec. 18, T. 30 N., R. 4 E. (Newtown Twp.), but 4½ feet of coal is reported[82] to have been exposed along the east bank of the river about a quarter of a mile south of the mouth of Prairie Creek. Coal 2 feet 6 inches thick is reported in a mine in the NE. corner SE. ¼ sec. 13, T. 30 N., R. 3 E. (Reading Twp.). Between this mine and the southeast corner of the quadrangle no information about the thickness of the coal is available, and it may have been eroded prior to the deposition of the overlying Gimlet sandstone. This occurred at least locally in the south part of sec. 5 where the sandstone directly overlies the underclay of the coal. Elsewhere the coal is 1 foot 3 inches to 1 foot 6 inches thick.

A number of borings in the area south of Streator, near Reading and Ancona, penetrated from 2 feet to 2 feet 8 inches of coal, although the coal was thinner or absent at many places (fig. 119). The thickness of the coal in the southwest part of the quadrangle is not known but borings a short distance west of the quadrangle penetrated 3 to 3½ feet of coal (app. B, 44, 49, 54).

*Correlation.*—This coal is correlated with the "Upper Vein" coal at LaSalle and coal No. 7 at Sparland. The absence of clay or shale partings is characteristic of coal No. 7 in the LaSalle area and aids in its differentiation from coal No. 6 which in both areas contains several partings. The coal can be traced in borings both to LaSalle and Sparland (app. B, 40-54).

### *Farmington shale*[83] (*Unit 61*)

*Distribution and outcrops.*—The Farmington shale (Unit 61, fig. 80) underlies approximately the same area as coal No. 7 but is known to be locally absent and may be missing in extensive areas as a result of erosion prior to the deposition of the overlying Gimlet sandstone. The shale crops out along Vermilion River in the Streator quadrangle in sec. 18, T. 30 N., R. 4 E. (Newtown Twp.), and in secs. 5 and 8, T. 29 N., R. 4 E. (Amity Twp.) (geol. secs. 27, 28).

[82]Freeman, H. C., Geology of Livingston County: Geological Survey of Illinois, vol. 6, p. 238, 1875.

[83]Named for Farmington, Fulton County, Ill., near which it crops out.
Wanless, H. R., Pennsylvanian correlations in the Eastern Interior and Appalachian coal fields: Geol. Soc. America, Spec. Paper 17, p. 83, 1939.

*Thickness.*—The shale has a maximum thickness of 6 feet about a mile above the waterworks dam (geol. sec. 27) and also near the south boundary of the quadrangle (geol. sec. 28). Borings a short distance west of the Streator quadrangle penetrated 20 to 50 feet of Farmington shale, and similar thicknesses may occur in the southwest part of the quadrangle.

*Lithology.*—The Farmington shale is commonly gray to dark gray and slightly gritty and contains layers of small limonite-stained ironstone concretions. The lower foot of the shale exposed on the north bank of Vermilion River at the south boundary of the Streator quadrangle is black, thin-bedded, and soft, and in borings west of the Streator quadrangle black shale is commonly recorded in the lower part of the shale (app. B, 40, 41, 44, 52-54).

*Correlation.*—The shale is correlated with the Farmington shale in the type area on the basis of its position overlying the Sparland (No. 7) coal.

## Gimlet Cyclothem[84]

The Gimlet cyclothem contains the youngest bedrock strata exposed in the Marseilles-Ottawa-Streator area. It is characterized by the presence of red shale and nodular limestone above the basal sandstone and by the absence of a coal and underclay (fig. 81). The limestone is not definitely in place in this area.

The cyclothem is 40 to 50 feet thick where exposed along Vermilion River upstream from about half a mile below the mouth of Prairie Creek, in the southeast part of the Streator quadrangle. It probably also underlies the west and southwest part of the quadrangle where it is concealed by glacial drift and younger bedrock strata (pl. 11).

The cyclothem rests unconformably on the Sparland cyclothem (p. 136). Its contact with overlying strata is not exposed.

The correlation with the type area of the cyclothem along Gimlet Creek near Sparland is based on the identification of the sequence of red shale and nodular limestone with a similar succession ex-

[84]Wanless, H. R., Pennsylvanian cycles in western Illinois: Illinois Geol. Survey Bull. 60, p. 182, 1931.
Named for Gimlet Creek, west of Sparland, Marshall County, along which it is well exposed.

| Stratigraphic Unit Number | Section | Thickness | Material | Name |
|---|---|---|---|---|
| 64 | | 3′- 6′ | LIMESTONE, GRAY, NODULAR | LONSDALE |
| 63 | | 10′ | SHALE, GRAY, RED, GREEN | |
| 62 | | 30′- 40′ | SANDSTONE, SILTY, GRAY, FINE-GRAINED, MICACEOUS, MASSIVE TO THIN BEDDED | |

FIG. 81.—Generalized section of the Gimlet cyclothem.

posed at Sparland and LaSalle and recorded in many borings in LaSalle, Marshall, and Woodford counties, west of the Streator quadrangle (app. B, 40, 41, 47). Throughout northern Illinois the limestone and red shale occur at the base of a series of alternating limestones and shales in which sandstones are rare and coals are generally lacking or thin. The Gimlet sandstone below the red shale is the uppermost persistent sandstone in the Pennsylvanian system of northern Illinois.

### STRATIGRAPHIC UNITS

#### *Sandstone* (*Unit 62*)

*Distribution and outcrops.*—The basal sandstone (Unit 62, fig. 81) of the Gimlet cyclothem crops out at many places along Vermilion River from about a mile above the waterworks dam southeast of Streator to the south margin of the Streator quadrangle (geol. secs. 27-29[85]; fig. 82).

*Thickness.*—The entire thickness of the sandstone is not exposed at any one locality. Bluffs of sandstone 15 to 20 feet high are exposed at many places. The maximum thickness exposed is about 30 feet in bluffs along the north bank of the river near the center of sec. 5, T. 29 N., R. 4 E. (Amity Twp.). The sandstone is probably at least 40 feet thick in some places. Sandstone 100 feet thick is reported in one boring a short distance west of the quadrangle (app. B, 54), but other borings usually penetrated less than 50 feet of sandstone.

[85]The geologic sections are given in appendix A.

*Lithology.*—The sandstone is silty, slightly clayey, gray to brownish-gray where fresh but light buff with small limonitic specks where weathered, fine-grained, and slightly calcareous (app. D, table 5, Nos. 38-43). It commonly occurs in massive beds, some of them cross-bedded, but locally contains some thin beds. It is composed of extremely angular quartz grains of sand, most of them secondarily enlarged, and contains a large amount of mica. It is sufficiently firm to form vertical cliffs 15 to 20 feet high along the river. The base of the sandstone is everywhere sharp, and the sandstone rests unconformably on the Farmington shale.

*Correlation.*—The sandstone is correlated with the sandstone at the base of the Gimlet cyclothem at LaSalle and Sparland on the basis of stratigraphic position.

#### *Shale* (*Unit 63*)

About 10 feet of gray, green, and red shale (Unit 63, fig. 81), the youngest bedrock exposed in the Streator quadrangle, locally overlies the Gimlet sandstone in outcrops along Vermilion River near the southeast corner and may underlie the southwest part of the quadrangle. The lower part of the shale is exposed along the north side of the river in the NE. ¼ SW. ¼ SW. ¼ sec. 20, and along the west bank of the river near the north line of sec. 32, T. 30 N., R. 4 E. (Newtown Twp.). The lower 2 to 4 feet of shale is gray but the upper part, although predominantly red, is partly interbedded gray and red and partly mottled red and green. The character of the beds is especially well shown in outcrops near Bradley

Fig. 82.—Basal sandstone (Unit 62) of the Gimlet cyclothem along Vermilion River, SE. ¼ SW. ¼ sec. 29, T. 30 N., R. 4 E. (Newtown Twp.), Streator quadrangle.

Bridge just south of the quadrangle (geol. sec. 29). The shale is uniformly present in outcrops near LaSalle and Sparland and is recorded in many borings just west of the quadrangle (app. B, 40, 47, 54).

### *Lonsdale limestone*[86] (*64*)

Large blocks of limestone (Unit 64, fig. 81) up to 5 to 6 feet thick occur along Vermilion River at several places south of the mouth of Prairie Creek (fig. 83). They do not appear to be in place anywhere in the area but their large size and abundance suggests that they are not far removed from bedrock ledges.

They are abundant along Vermilion River half a mile south of Prairie Creek and about half a mile north of the south margin of the quadrangle, and along Mole Creek and Long Point Creek in sec. 31, T. 30 N., R. 4 E. (Newtown Twp.), and sec. 6, T. 29 N., R. 4 E. (Amity Twp.), Streator quadrangle.

The limestone is gray where fresh, light gray to white where weathered, crystalline to subcrystalline, and nodular with irregular masses of calcite. Usually the nodules are rounded so that the bed resembles a conglomerate. Fossils are common and *Composita subtilita* and *Squamularia perplexa* are abundant.

The limestone is similar in lithology to the Lonsdale limestone exposed near LaSalle[87] and Sparland and in the type area near Peoria.

### Unexposed Strata

The sharp westward dip of the strata on the west slope of the LaSalle anticline (pl. 12) carries the beds exposed along Vermilion River to considerable depths within a few miles west, so that much younger, that is stratigraphically higher, strata form the surface bedrock in the southwest part of the Streator quadrangle. There are neither exposures nor any available records of borings in the area to reveal their character, but a reasonably accurate conception of the succession of strata may be obtained from a study of the records of numerous borings in areas west of the quadrangle (app. B, 40-54) and from exposures along Illinois and Vermilion rivers in the LaSalle quadrangle. They consist of 200 feet of limestones, gray shales, red shales, clays, and thin coals. Some of the limestones grade into calcareous shales and some of the shales are gray in one place and red in another. Consequently, exact correlations and subdivisions into cyclothems are difficult, especially in the records of borings, but studies of the outcrops near LaSalle show that probably six cyclothems are represented.

## TERTIARY (?) SYSTEMS

A thin deposit of limonitic conglomerate and sandstone that is exposed over the St. Peter sandstone and under glacial drift in small areas in the northeast part of the Ottawa quadrangle and the northwest part of the Marseilles quadrangle may be of Tertiary age. In the Ottawa quadrangle the deposit is 2-4 feet thick where exposed in the east bluff of Fox Valley at Wedron (geol. sec. 68A) and along the lower part of a tributary valley in the SW. ¼ sec. 9, T. 34 N., R. 4 E. (Rutland Twp.). In the Marseilles quadrangle northeast of Serena there is an outcrop of 2 feet of conglomerate in a small gully on the west side of Fox River at the northwest end of a bluff of St. Peter sandstone in the NE. ¼ sec. 19, T. 35 N., R. 5 E. (Serena Twp.).

*Lithology.*—The pebbles in the conglomerate consist largely of concretionary

[86] Named for the old Lonsdale quarries, west of Peoria. Udden, J. A., Geology and mineral resources of the Peoria quadrangle: U. S. Geol. Survey Bull. 506, pp. 38-40, 1912.

[87] Cady, G. H., Geology and mineral resources of the LaSalle and Hennepin quadrangles: Illinois Geol. Survey Bull. 37, p. 63, 1919.

masses of limonite up to 4 inches in diameter, rounded dark brown polished chert pebbles mostly ¼ to 1 inch in diameter, light brown rough-surfaced chert pebbles mostly less than 1 inch in diameter, and limonitic argillaceous pebbles which look like leached limestone. A few of the argillaceous pebbles effervesce slightly in acid. Some of the chert pebbles are oölitic and some are fossiliferous. Pebbles of St. Peter sandstone and gray and black shale, micaceous sandstone, and coal from the Pennsylvanian strata are common and locally form a large percentage of the deposit. Well-rounded pebbles of colorless and rose quartz up to one-half inch in diameter and small rounded fragments of red "iron-ore" are common.

The pebbles are imbedded in a matrix of quartz sand much of which is well rounded like the sand in the underlying St. Peter formation. Beds almost entirely sand are common. The entire deposit is impregnated or cemented with limonite. Locally the deposit consists largely of banded or earthy limonite with only scattered pebbles and sand grains. The conglomerate is well bedded, commonly in layers 1 to 2 inches thick, but beds up to 6 inches thick are present. Cross-bedding is common.

*Stratigraphic relations.*—The conglomerate has a sharp contact with the underlying St. Peter sandstone, although usually the upper few inches of the St. Peter sandstone is stained brown with limonite and locally it is cemented into a hard layer. The conglomerate is overlain sharply by calcareous glacial deposits. At the outcrop northeast of Serena the glacial material is gravel, but at Wedron it is till, probably Illinoian in age. At both these outcrops the conglomerate occurs on a relatively flat bedrock surface at an elevation of 540 to 550 feet, 15 to 25 feet below the highest bedrock elevations in that part of the area.

*Correlation.*—The conglomerate is similar in lithology to the limonite-cemented conglomerate at Waukon, Allamakee county, Iowa, and at several places in Wisconsin near Seneca and Sparta, which is considered part of the Windrow formation.[88] The Windrow formation is considered by some geologists to be Cretaceous[88] but others believe it to be Late Tertiary.[89] The conglomerate is also similar to but contains much less chert and is more cemented than the chert gravels which occur below glacial drift and overlie bedrock in a small area near Peoria[90] and are extensively present in the driftless area of Calhoun county, Illinois,[91] and in southern Illinois.[92] These deposits have been correlated with the Late Tertiary.

Fig. 83.—Slumped blocks of Lonsdale limestone on the east side of Vermilion River, NE. ½ sec. 19, T. 30 N., R. 4 E. (Newtown Twp.), Streator quadrangle.

As the conglomerate rests on a bedrock surface that is thought to be part of a Late Tertiary peneplain (p. 264), it is probably no older than Late Tertiary. It is overlain by till correlated with the Illinoian and therefore is pre-Illinoian in age. Although the conglomerate might possibly have been formed early in the Pleistocene period before the area was glaciated, its strongly cemented character, the presence of quartz pebbles foreign to the bedrock of the area, the absence of igneous pebbles, and the lack of similarity to any glacial gravels suggest that the conglomerate is Late Tertiary in age. It is impossible to assign it definitely to any one Tertiary system.

[88]Thwaites, F. T., and Twenhofel, W. H., Windrow formation, an upland gravel formation of the Driftless area and adjacent areas of the Upper Mississippi Valley: Geol. Soc. Amer. Bull. vol. 32, pp. 293-314, 1921.

[89]Trowbridge, A. C., The erosional history of the driftless area: Univ. of Iowa Studies in Nat. Hist. vol. 9, No. 3, 1921.

[90]Udden, J. A., Geology and mineral resources of the Peoria quadrangle Illinois: U. S. Geological Survey Bull. 506, p. 50, 1912.

[91]Rubey, W. W., Geology and mineral resources of the Hardin and Brussels quadrangles: Illinois Geol. Survey, unpublished manuscript.

[92]Lamar, J. E., and Sutton, A. H., Cretaceous and Tertiary sediments of Kentucky, Illinois, and Missouri: Am. Assn. Pet. Geologists Bull. vol. 14, pp. 857-859, 1930.

# PLEISTOCENE[1] SYSTEM

## INTRODUCTION

Unconsolidated materials varying widely in character overlie the bedrock throughout a large part of northern North America, northern Europe, and other continents. Many hypotheses, mostly of a cataclysmic nature, were invented to explain these deposits, but their true significance was recognized only about 90 years ago, when Louis Agassiz, the great naturalist, recognized the similarity of these materials to the deposits made by glaciers in his native Switzerland. From this beginning has developed the conception of a world-wide period of continental glaciation in relatively recent geologic time.

At first it was assumed that a single advance of the ice was responsible for the deposits, but discovery of weathered zones and fossiliferous materials within the deposits, indicative of nonglacial conditions, led to the realization that there was a succession of glacial advances separated by interglacial stages, and now four major glaciations are recognized (p. 147).

Many types of deposits were formed during the Pleistocene period. The glaciers and their melt waters laid down some deposits beneath the ice and others on the plains, in the valleys, or in lakes in front of the ice. The wind reworked some of the deposits, and plant debris accumulated in swampy areas.

## Drift

The deposits laid down by the glaciers and their melt waters are called *drift* and form the greater part of the Pleistocene deposits. They include the widespread bouldery clay and silt which underlies nearly all the upland areas, and the gravel and sand deposits which occur mostly in the valleys.

### TILL

The debris within the glaciers was of all sizes from clay to boulders. When the ice melted some of this material was dropped as a heterogeneous mixture which is called *till.* The till occurs in ridges or *moraines* that were deposited at the position of the glacial margin when melting balanced advance, and in plains of *ground-moraine* deposited behind the moraines when the glaciers wasted away.

The till in the Marseilles-Ottawa-Streator area is composed of clayey silt or silty clay, usually sandy, in which pebbles, cobbles, and boulders are scattered irregularly. Although conspicuous, the larger fragments comprise a small proportion, usually less than 10 per cent, of the till. The materials vary from well-rounded to angular. Glacial striae, scratches made by glacial action, are common on many of the rock fragments, especially on the limestones and dolomites. Locally the till shows faint traces of bedding, usually contorted.

### GLACIO-FLUVIAL AND GLACIO-LACUSTRINE DEPOSITS

The glacial waters, wherever they possessed sufficient energy, picked up rock debris and later deposited it—some of it in or under the glacier, some along its front, some on the plains or along the valleys leading away from the ice-front, and some in lakes in front of the glaciers. The deposits made in and by glacial streams are termed *glacio-fluvial*; those in lakes, *glacio-lacustrine.* The water transportation roughly sorted the materials by size, the coarsest materials being deposited nearest the ice and the finer at greater distances, and generally the farther the material was carried the more it was worn and the better it was sorted.

*Eskers.*—At some places sand and gravel accumulated in fissures or crevasses and in channels under the glacier, and later melting of the ice left the gravel in a ridge called an *esker* (p. 161). A large esker occurs four miles south of Ottawa (pl. 2). Esker deposits are generally poorly sorted, contain lenses of till, may be covered with till, and usually contain more clay and silt than do the glacio-fluvial deposits in front of the ice. Many of the pebbles are angular.

*Deposits in subglacial channels.*—Along some subglacial drainage lines the escaping melt-water had sufficient energy to prevent any considerable deposition of either till or gravel but instead formed broad channels, especially in the Farm

[1]Lyell, C., Charlesworth's Mag. Nat. Hist., vol. 3, p. 323, footnote, 1839.

Ridge and Marseilles moraines. Most of the channels, however, have at least locally a thin deposit of gravel, and gravel deposits of considerable size are present at a few places. The materials are similar to those in eskers.

*Kames.*—Occasionally, usually in the moraines, there are hills or mounds of gravel and sand which are called *kames.* They represent local deposits from glacial streams, either in holes in the glacier into which the streams plunged, or in crevasses, or at the ice-front where the glacial streams emptied with a sudden reduction in velocity that forced them to drop their load. The materials in kames are similar to those in eskers. Kames are locally present on the Farm Ridge moraine northwest of Streator.

*Outwash-plains and valley-trains.*—The material carried away from the glaciers by the melt-water is called *outwash.* At some places the water spread the outwash in front of the glacier to form *outwash-plains;* at other places the water was concentrated in valleys leading from the ice and deposited the outwash in *valley-trains.* Many of the valley-train deposits extended hundreds of miles from the ice-front and so are better sorted, more rounded, and usually contain less clay than the subglacial deposits. Outwash-plains are locally present along the front of the Farm Ridge and Chatsworth moraines. Remnants of valley-train deposits are common along Illinois and Fox valleys.

*Lake deposits.*—At some places the melt-water carried outwash into lakes of varying size and depth near the ice-front. Where the rivers entered the lakes their current was checked suddenly and the coarser material, gravel and sand, was deposited in deltas that are characterized by steeply dipping, parallel beds, called *foreset beds*, which in places are overlain by horizontal beds, called *topset beds*. Most of the deltas were formed near the margin of the ice, as shown by the presence of balls of till and soft decomposed well-rounded pebbles and boulders of igneous rocks which could not have been transported any great distance by running water even if frozen. The deltal materials are poorly sorted and contain a considerable amount of clay and silt both in beds and disseminated through the deposits. Finer sands, silts, and clays were carried out and settled in the quieter waters of the lakes to form well-stratified, thinly laminated deposits. Gravel deltas and laminated silts and clays deposited in lakes are common in the Marseilles-Ottawa-Streator area.

### Eolian Deposits

Deposits of sand and silt formed by the wind during the glacial stages are found bordering fine outwash deposits. Silt deposited by the wind is known as *loess.* It is usually nonbedded, and uniform in texture and calcareous except where weathered. Much of it was picked up by the wind from the aggrading flats of valleys in which the glacial floods deposited large quantities of fine-grained material. Some of it may have been blown considerable distances. Loess is widespread in the Marseilles-Ottawa-Streator area, but it is very thin on and east of the Marseilles moraine.

Sand deposited in the valley-flats by the glacial rivers was locally blown into *dunes.* Only a few dunes occur in the Marseilles-Ottawa-Streator area but they are abundant in nearby areas.

### Other Deposits

The processes active in the interglacial stages were the same as those active at present and the deposits formed were similar to those now accumulating. Weathering and biologic processes produced soils; peats accumulated in the swampy depressions; lakes were filled with silts washed from the surrounding areas and also with vegetable growth; sand and gravel, reworked from the glacial deposits, accumulated along the streams; and slope-wash and alluvial fans accumulated in the valleys.

### Source of Materials

The glacial deposits are composed of materials picked up by the ice from the area across which it advanced. Unconsolidated materials were easily engulfed by the ice, and many blocks, some of large size, were plucked from the bedrock. Consequently a great variety of materials are present in glacial drift, and they range

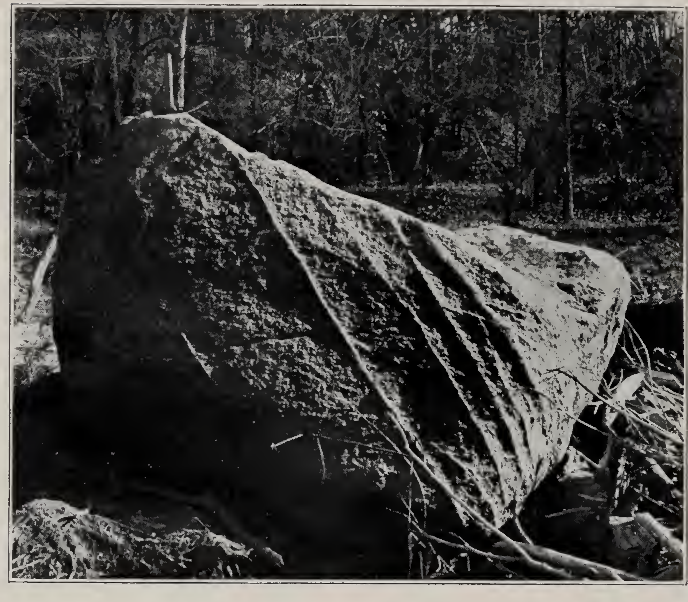

Fig. 84.—Large igneous boulder on South Kickapoo Creek, southeast of Marseilles. The size of the boulder is shown by the hammer on its top. (Illinois State Geological Survey Bull. 27, p. 61.)

in size from minute particles to boulders many feet in diameter. Some of the boulders are as large as 10 feet in diameter and weigh more than 10 tons (fig. 84). Among the glacial rocks present in the Marseilles-Ottawa-Streator area are many fragments of igneous and metamorphic rocks which form the bedrock surface no nearer than the Lake Superior region several hundred miles north. Fragments of dolomite and limestone typical of those exposed near Chicago are abundant. Sandstone, shale, and coal from the local bedrock are common to abundant. Much of the fine-grained materials in the glacial deposits was formed by the grinding of the rocks against one another and on the bedrock during movement of the ice.

### Thickness

The average thickness of the Pleistocene deposits in the Marseilles-Ottawa-Streator area is probably at least 100 feet. The maximum known thickness, about 250 feet, is in wells, one on the crest of the Marseilles moraine about four miles north of Marseilles, and another at Grand Ridge on the Farm Ridge moraine, but neither of these wells reached the base of the deposit, and it seems probable that in some parts of the area the deposits are as much as 300 feet thick. The thinnest deposits in the upland areas occur in the flat plains near Ottawa and along Vermilion Valley near Streator where they are locally only about 25 feet thick.

The variations in thickness of the deposits may be perceived by a comparative study of the present topography and the bedrock topography (pls. 4-6). The difference in elevation between the two surfaces is the thickness of the deposits at any point.

### Differentiation of Drift Sheets

Differentiation of the deposits of one glacial age from those of another is based largely on the recognition of interglacial ages, when long intervals of weathering produced soils and leached the carbonates from a considerable thickness of drift. Because of the abundance of limestone and dolomite in the areas traversed by the glaciers which invaded Illinois, the glacial materials as originally deposited were all highly calcareous. Consequently, a layer of noncalcareous drift indicates an interval of weathering, and its total thickness is a rough measurement of the

| SYSTEM | STAGE | SUB-STAGE | UNIT | SECTION | MAXIMUM THICKNESS | MATERIAL | ORIGIN |
|---|---|---|---|---|---|---|---|
| PLEISTOCENE | RECENT | | | | 15′ | SILT, CLAY, SAND, GRAVEL, PEAT | STREAM, LAKE, WIND, GRAVITY DEPOSITS |
| | WISCONSIN | MAN-KATO | LAKE CHICAGO | | 40′ | GRAVEL, SAND | OUTLET RIVER DEPOSITS |
| | | CARY | VALPARAISO | | 30′ | GRAVEL, SAND | FOX LAKE ? OUTWASH |
| | | | | | 25′ | GRAVEL, SAND | WEST CHICAGO? OUTWASH AND LATE KANKAKEE TORRENT RIVER DEPOSITS |
| | | | | | 10′ | SILT, SAND, GRAVEL | KANKAKEE TORRENT LAKE DEPOSITS |
| | | TAZEWELL | MARSEILLES | | 10′ | GRAVEL | FOX RIVER TORRENT? DEPOSITS |
| | | | | | 12′+ | SAND, GRAVEL | DELTAS IN LAKE LISBON |
| | | | | | 20′ | GRAVEL, SAND | DELTAS IN LAKE ILLINOIS |
| | | | | | 200′ | TILL, GRAVEL, SAND | ICE DEPOSITS, KAMES, ESKERS, FRONTAL OUTWASH, SUBGLACIAL DEPOSITS |
| | | | CHATSWORTH | | 40′ | TILL, GRAVEL, SAND | ICE DEPOSITS, FRONTAL OUTWASH |
| | | | FARM RIDGE | | 30′ | GRAVEL, SAND | DELTAS IN LAKE ILLINOIS |
| | | | | | 60′ | TILL, GRAVEL, SAND | ICE DEPOSITS, FRONTAL OUTWASH |
| | | | CROPSEY | | 25′ | SAND, GRAVEL, SILT, CLAY | LAKE ANCONA DEPOSITS |
| | | | | | 40′ | TILL | ICE DEPOSITS |
| | | | | | 10′ | GRAVEL, SAND | LAKE ILLINOIS DEPOSITS |
| | | | BLOOMINGTON | | 10′ | SILT, SAND, GRAVEL | LAKE ILLINOIS DEPOSITS |
| | | | | | 50′ | TILL | ICE DEPOSITS |
| | | | | | 25′ | GRAVEL, SAND | OUTWASH |
| | | | SHELBYVILLE | | 17′ | SILT, CLAY, SAND | LAKE KICKAPOO DEPOSITS |
| | | | | | 30′+ | SAND, GRAVEL | OUTWASH |
| | | | | | 15′ | TILL | ICE DEPOSITS |
| | SANGAMON | | | | 5′ | PEAT, MUCK | SWAMP DEPOSITS |
| | ILLINOIAN | | | | 60′ | TILL | ICE DEPOSITS |
| | KANSAN | | | | 3′ | TILL | ICE DEPOSITS |
| | PRE-KANSAN | | | | 10′ | SAND, SILT | LAKE DEPOSITS |

FIG. 85.—Generalized columnar section of the Pleistocene deposits in the Marseilles, Ottawa, and Streator quadrangles.

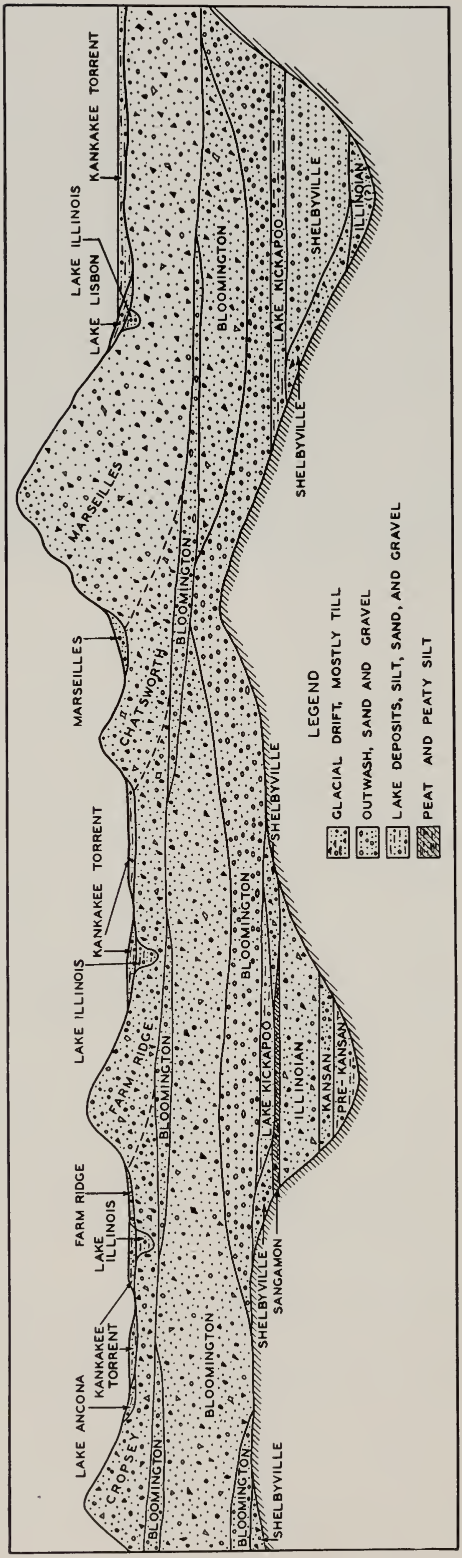


FIG. 86.—Diagrammatic cross-section showing the relations of Pleistocene deposits.

length of the interval. In favorable localities long-continued weathering of glacial till produced a layer of *gumbotil*, a plastic clayey material from which not only the carbonates have been leached but in which many relatively insoluble silicates have been decomposed. Gumbotil is found between each of the glacial stages. Associated with the soils are interglacial deposits of loess, peat, and alluvial materials, many of which contain remains of plants and animals.

In many localities the interglacial deposits and weathered zones were completely eroded where overridden by later glaciers. In such cases differentiation of the drift sheets may be difficult or impossible. However, because of its greater age and overriding by later glaciers, the older till in many cases is more compact and harder and so may be sharply separated from the younger. Sometimes oxidized zones along joints in the older till are absent in the younger till. The tills deposited by different glaciers often vary in color and composition. Most tills are shades of gray—light, dark, yellowish-gray, greenish-gray—but others are pink or green. Some tills have a silty, others a clayey matrix; some are very sandy, some very gravelly. Although such characteristics are rarely uniform and seldom reliable for long-distance correlations, they are helpful in tracing different tills from known areas to places where the more diagnostic characteristics are lacking, and they are commonly of value in correlating locally even the minor subdivisions of the various stages.

## Classification

The major subdivisions and nomenclature of the Pleistocene system exposed in Illinois and adjacent states and the comparable stages in Europe are shown in table 5. This nomenclature is especially applicable to the deposits of the glaciers radiating from the Hudson Bay area (fig. 103).

Each of the series consists of the deposits of a climatic cycle comprising an age of glaciation followed by an interglacial age of moderated climate, the Recent age being recognized as having the characteristics of an interglacial age. The deposits of the last glacial age are subdivided into substages on the basis of major retreats and readvances of the ice with varying degrees of development of the ice centers. However, the intervals of retreat were so short that very slight weathering occurred and no materials comparable to the soils of the interglacial ages are found between the substages.

## Generalized Section

The surface deposits in the Ottawa, Marseilles, and Streator quadrangles are of Wisconsin age (figs. 85, 86). The moraines were formed during Tazewell time and most of the glacio-fluvial de-

Table 5.—Classification of the Pleistocene System[a]

| *Rock terms:* System<br>*Time terms:* Period | Series<br>Epochs | Stages<br>Ages | Substages | Stages in Europe |
|---|---|---|---|---|
| Pleistocene or Glacial | Eldoran | Recent | | |
| | | Wisconsin (glacial) | Mankato (Late Wisconsin)<br>Cary (Middle Wisconsin)<br>Tazewell (Early Wisconsin)<br>Iowan | Würm |
| | Centralian | Sangamon (interglacial) | | Riss-Würm |
| | | Illinoian (glacial) | | Riss |
| | Ottumwan | Yarmouth (interglacial) | | Mindel-Riss |
| | | Kansan (glacial) | | Mindel |
| | Grandian | Aftonian (interglacial) | | Günz-Mindel |
| | | Nebraskan (glacial) | | Günz |

[a]Kay, G. F., and Leighton, M. M., Eldoran epoch of the Pleistocene period: Geol. Soc. America Bull., vol. 44, p. 673, 1933.

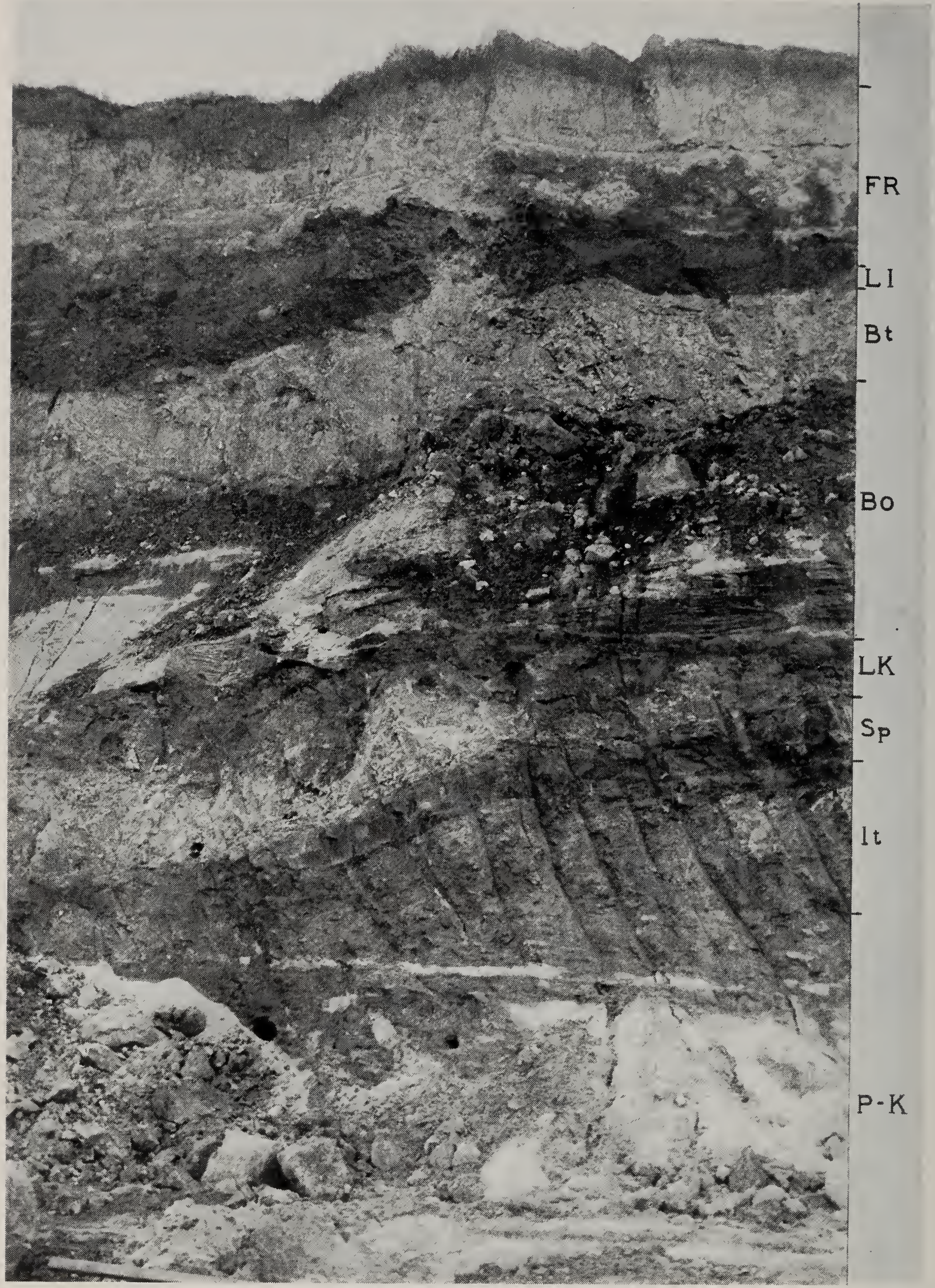


FIG. 87.—Highest part of the overburden at the Wedron Silica Company pit (geol. sec. 68) showing variable character of the Pleistocene deposits.
FR, Farm Ridge till; LI, Lake Illinois silt; Bt, Bloomington till; Bo, Bloomington outwash sand and gravel; LK, Lake Kickapoo silt; Sp, Sangamon peat; It, Illinoian till; and P-K, pre-Kansan (?) lake silt and sand.

posits along the valleys and in part of the upland areas accumulated in Cary time. Along Illinois Valley there are deposits made in Mankato time in part. Deposits of the Sangamon interglacial age and of the Illinoian and Kansan glacial ages are buried by the younger drift but are exposed along some of the deeper valleys. No single part of the area is known to contain all of the deposits and such a possibility is almost precluded by the glacial origin of the deposits. While the glaciers generally tended to build up a sequence of successive layers of till, they also tended to erode some of the older unconsolidated drift, and also the rivers of melt-water from the same series of glaciers deepened the valleys and in many cases deposited their materials at successively lower levels. In view of the repeated advance of the glaciers over this area it is remarkable that successions as complete as those found should exist. Many of the deposits can be traced for long distances throughout the area and many exposures show a strikingly uniform sequence.

The most nearly complete sequence in the area, exposed in the overburden stripped from the St. Peter sandstone in the pit of the Wedron Silica Company at Wedron (fig. 87 and geol. sec. 68[2]), is one of the most notable individual exposures of Pleistocene deposits in the State. It contains till deposited during the Kansan (?) and Illinoian ages and during the Bloomington and Farm Ridge intervals of the Wisconsin age, interglacial deposits of Sangamon age, and lake beds formed before the Kansan (?) till and during the Shelbyville, Bloomington, and Valparaiso intervals of Wisconsin age. The pre-Illinoian deposits are not exposed elsewhere in the area, and the Sangamon deposits are exposed at only a few other places, but many similar sections of the Wisconsin deposits are exposed along Fox and Illinois valleys.

## Stratigraphic Relations

The Pleistocene materials are separated from the underlying deposits by a great unconformity (fig. 86). The youngest deposits exposed below the Pleistocene are Pennsylvanian in age, except for thin local deposits of Tertiary age, so that deposits of the Permian period of the Paleozoic era, of all of the Mesozoic era, and of nearly all of the Cenozoic era are lacking. Because the Pennsylvanian and older beds are slightly tilted and were deeply eroded before the Pleistocene deposits accumulated, all of the Pennsylvanian and older strata exposed in the area (pl. 11) are at least locally overlain directly by the Pleistocene deposits. The contact of the unconsolidated Pleistocene deposits with the older consolidated strata is usually sharp and easily recognized.

[2]The geologic sections are given in appendix A.

## Bedrock Topography

As shown by well records and outcrops, the surface of the bedrock on which the Pleistocene deposits lie was a gently undulatory plain in which broad and deep valleys were incised (pls. 4-6). The surface had a maximum relief of about 250 feet and was in a stage of late youth in the erosion cycle (p. 21).

The lowest part of the bedrock surface is below 400 feet in elevation above sea-level in the bottom of an old valley near the northwest corner of the Streator quadrangle and the highest part is in the northeast corner of the Marseilles quadrangle, where the bedrock surface is slightly more than 650 feet above sea-level. Because the well records are more numerous and better distributed in most of the Ottawa and Marseilles quadrangles than in the Streator quadrangle, the bedrock surface map is more detailed for the Ottawa and Marseilles than for the Streator quadrangle except along Vermilion River where the bedrock is exposed.

The maps show two strikingly divergent drainage systems. One is that of the present valleys of Illinois, Fox, and Vermilion rivers which are deeply entrenched in the bedrock. The other consists of equally prominent valleys which are filled with Pleistocene deposits and are not reflected in the present topography. The present valleys are obviously much later in origin as they are cut through the glacial deposits which fill the older valleys. The older valleys contain Kansan till, which indicates they are pre-Kansan and may be pre-Pleistocene in age. The earlier valleys cut in the bed-

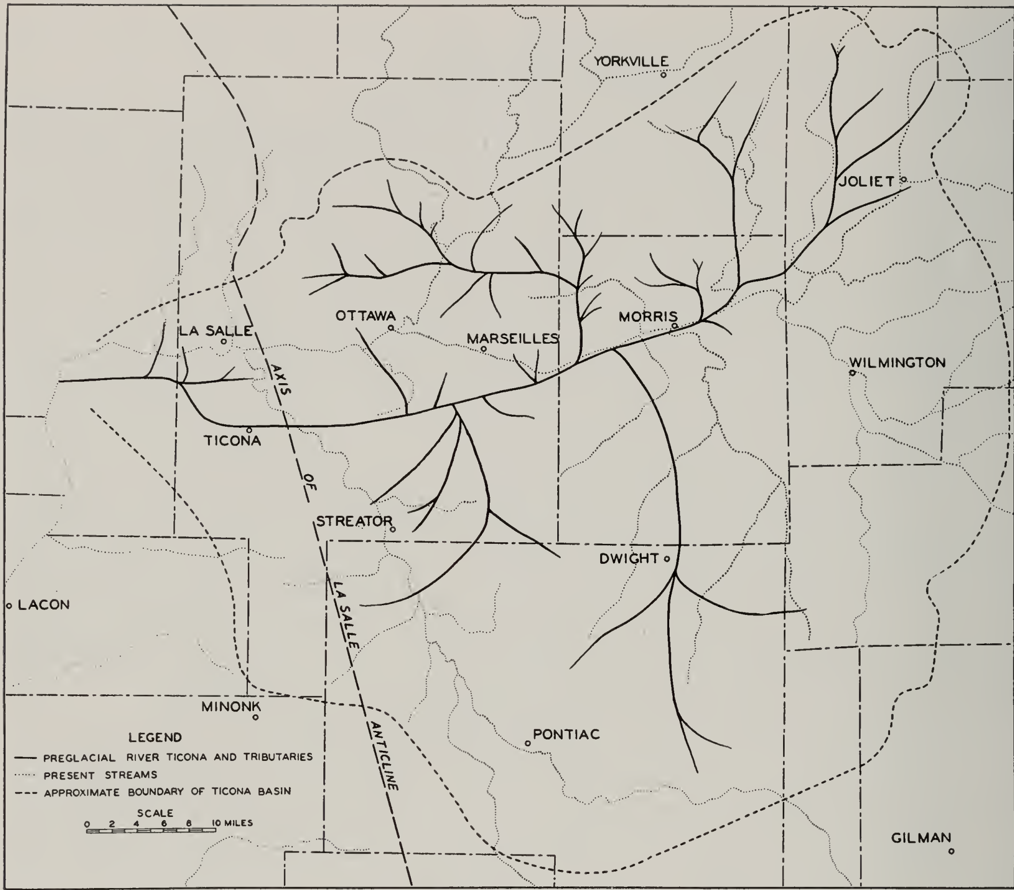


Fig. 88.—Preglacial River Ticona.

rock were completely filled by, if not before, the latest glaciers whose distribution determined the position of the present valleys.

The major river of the bedrock surface is called River Ticona[3] for the railroad station of Ticona, one mile northeast of Tonica and two miles west of the Streator quadrangle, which is situated above the old valley. One branch of River Ticona coursed eastward through the north part of the Ottawa and Marseilles quadrangles, turned sharply south in the east part of the Marseilles quadrangle, and joined a major branch from the east at the present Illinois Valley. The river then flowed southwest, left the Marseilles quadrangle near the southwest corner, crossed the southeast corner of the Ottawa quadrangle, and flowed west through the north part of the Streator quadrangle (fig. 88). Ticona Valley continues westward from the Streator quadrangle about five miles, bends northwest into the southern part of the LaSalle quadrangle, and then turns westward parallel to the present Illinois Valley and only two miles south of it.[4] About four miles northeast of Hennepin the valley joined a much larger valley the course of which was north and south, almost at right angles to Ticona Valley. Where Ticona Valley crosses the present Fox Valley near Wedron, its bottom is at an elevation of about 525 feet, which is above that of Fox Valley; where it crosses Illinois Valley near Seneca, its

[3]Willman, H. B., Pre-glacial River Ticona, Illinois Acad. Sci. Trans. vol. 33, pp. 172-175, 1940; Illinois Geol. Survey Circular 68 pp. 9-12, 1940.

[4]Cady, G. H., Geology and mineral resources of the LaSalle and Hennepin quadrangles: Illinois Geol. Survey Bull. 37, pl. V, p. 96, 1919.

bottom is about 460 feet above sea-level, which is below the level of the present river; at Grand Ridge in the north part of the Streator quadrangle the bottom of the valley is below an elevation of 400 feet, so that it is probably about 150 feet below the base of Vermilion Valley, and at that point it is already at least 50 feet below the present Illinois River at Hennepin. The valley has a gradient of at least four feet per mile, which is about equal to that of the portion of Fox Valley in the area and about twice that of Illinois Valley through the area. At many places in the Marseilles-Ottawa-Streator area the valley was more than 100 feet deep, and across the northern part of the Streator quadrangle it was at least 200 feet deep. It had many tributaries.

## PRE-KANSAN STAGE

The oldest Pleistocene deposits exposed in the Marseilles-Ottawa-Streator area are some lake deposits which occur in a branch of Ticona Valley and are exposed only in the pit of the Wedron Silica Company (geol. sec. 68)[5]. They rest directly on bedrock and are overlain by till, probably Kansan in age.

### *Character*

The lake deposits consist of interbedded noncalcareous sand and silt. The sand is rusty-brown, very fine-grained, and occurs in 2- to 4-inch beds alternating with ¼- to 1-inch beds of light gray silt. The beds are mostly parallel with a general dip of 10 to 15 degrees northwest but locally they are contorted. The deposits are as much as 10 feet thick but in places are cut out completely by the overlying materials.

### *Correlation*

The age of the lake in which these deposits accumulated probably as a delta is uncertain. It may have existed at any time from the Nebraskan to the Kansan. If the overlying till is Kansan, as seems probable, the deposits may be Aftonian in age although their character suggests glacial outwash, perhaps in late Nebraskan or early Kansan time. However, no drift of Nebraskan age is known in northeastern Illinois.

[5]The geologic sections are given in appendix A.

## KANSAN STAGE[6]

The only exposure of definitely known pre-Illinoian probably Kansan till also occurs at Wedron (geol. sec. 68) in a branch of Ticona Valley, although drift of the same age may be present elsewhere in the preglacial valleys. Outcrops of till, possibly of Kansan age, occur along the middle fork of Mission Creek three miles east of Serena and in a road-cut just south of the southeast corner of the Streator quadrangle (p. 153).

### *Character*

At Wedron the Kansan till is greenish-brown, compact, noncalcareous, and sandy. It has a maximum thickness of 3 feet but is absent in the greater part of the outcrop. It overlies the interbedded sand and silt described above and is overlain sharply by calcareous Illinoian till from which it differs both in color and texture.

### *Correlation*

A considerable thickness of pre-Illinoian drift, probably Kansan, has been recognized near LaSalle,[7] a short distance west of this area. Kansan drift occurs over much of southern Illinois, and its distribution makes it seem highly probable that the Marseilles-Ottawa-Streator area was covered by the Kansan glacier. The extensive deposits of Kansan drift west of Illinois River are thought to have been deposited by a glacier from the Keewatin center. The Wedron locality is farther east than Kansan deposits from that center have been recognized, and the Kansan drift here is believed to be from the Labradorean center. The extensive Kansan deposits of southern Illinois are thought to have been deposited by the same glacier from the Labradorean center.[8] It is improbable that the Nebraskan glacier covered this area, as the nearest

[6]Named for the State of Kansas where it is widely distributed and is not overlain by younger glacial deposits.
Chamberlin, T. C., in Geikie, James, The Great Ice Age, pp. 753-764, 1894.
Chamberlin, T. C., The classification of American glacial deposits, Jour. Geology, vol. 3, pp. 270-277, 1895.

[7]Cady, G. H., Geology and mineral resources of the Hennepin and LaSalle quadrangles; Illinois Geol. Survey, Bull. 37, pp. 71-72, 1919.

[8]MacClintock, Paul, Correlation of the pre-Illinoian drifts of Illinois: Jour. Geology, vol. 41, pp. 710-722, 1933.

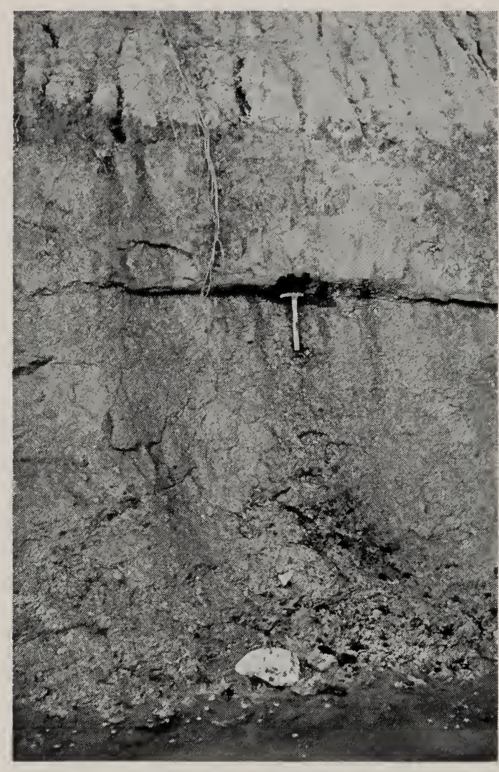

Fig. 89.—Sangamon peaty silt overlying Illinoian till (contact at head of hammer) and underlying Shelbyville drift along Mission Creek, east of Serena, NW. ¼ SE. ¼ NE. ¼ sec. 21, T. 35 N., R. 5 E. (Mission Twp.), Marseilles quadrangle (geol. sec. 39).

deposits identified as Nebraskan occur in northeastern Iowa[9] and west-central Illinois.[10]

## ILLINOIAN STAGE[11]

Illinoian drift probably underlies large areas in all three quadrangles, especially along Ticona Valley, but its presence is clearly established at only a few localities, as at Wedron and farther up Fox Valley, along Illinois Valley near Seneca, and near the southeast corner of the Streator quadrangle. Till having some characteristics which suggest it to be older than the Wisconsin drift but lacking a weathered zone to establish its pre-Wisconsin age crops out at many places along the Fox and Illinois valleys in the Marseilles quadrangle.

### *Character*

At Wedron the Illinoian till is variably yellow, gray, and brown, silty and gravelly, mostly highly calcareous, and contains wood fragments (geol. sec. 68). The upper 1 foot 6 inches is noncalcareous and is separated from unaltered till by 2 feet of brown oxidized calcareous till. The maximum thickness exposed is about 10 feet but the till is missing in part of the outcrop. It rests on the Kansan (?) till or on bedrock and is overlain by Sangamon deposits.

A yellow gravelly till similar to the Illinoian till exposed at Wedron, except that it has no leached zone at the top, crops out along Fox Valley two miles east of Serena (geol. sec. 38). The succession is also similar to that at Wedron in that the lower till is separated from typical Bloomington till by sand and gravel and laminated silts.

About three miles east of Serena, along the middle fork of Mission Creek, 5 feet of till at least as old as Illinoian and possibly as old as Kansan is exposed (geol. sec. 39 and fig. 89). The till is dark greenish-gray and very sandy and contains chert pebbles. The upper 3 to 5 feet is noncalcareous but at the west end of the outcrop the lower 2 feet is slightly calcareous. Brown calcareous oxidized till in slumped outcrops at a lower elevation downstream may be of the same age.

Pre-Wisconsin till, probably Illinoian, is reported[12] to occur along the ravine northwest of Seneca in the NE. ¼ sec. 23, T. 33 N., R. 5 E. (Manlius Twp.), Marseilles quadrangle, but is not exposed at present. The till, 5 feet thick, contained very little calcium carbonate and the boulders were largely decomposed.

In a road-cut one mile south of the Streator quadrangle, calcareous Wisconsin drift is underlain by greenish-brown hard noncalcareous sandy till (geol. sec. 102), believed to be of Illinoian age but it may be of Kansan age.

[9]Kay, G. F., and Apfel, E. T., The pre-Illinoian Pleistocene geology of Iowa: Iowa Geol. Survey, vol. 34, 1929.

[10]Bell, A. H., and Leighton, M. M., Nebraskan, Kansan, and Illinoian tills near Winchester, Illinois: Geol. Soc. America Bull., vol. 40, pp. 481-490, 1929.
Wanless, H. R., Nebraskan till in Fulton County, Illinois: Illinois Acad. Sci. Trans., vol. 21, pp. 273-282, 1929.

[11]Named for the State of Illinois where it is best exposed. Chamberlin, T. C., Editorial: Jour. Geology, vol. 4, pp. 872-876, 1896.

[12]Sauer, C. O., Geography of the Upper Illinois Valley: Illinois Geol. Survey Bull. 27, p. 72, 1915.

A compact dark bluish-gray calcareous till that has vertical oxidized brown bands along the joints occurs in many outcrops along Fox Valley and its tributary valleys and in several ravines along Illinois Valley in the Marseilles quadrangle. It is locally as much as 60 feet thick and is probably Illinoian in age. It is separated from the overlying pink Bloomington till by sand, gravel, and silt. Locally it rests directly on bedrock although in many areas the base is not exposed. It is well exposed at the following localities: (1) south bluff of Indian Creek in the SW. ¼ SW. ¼ NW. ¼ sec. 4, T. 34 N., R. 4 E. (Dayton Twp.), Ottawa quadrangle, (geol. sec. 65); (2) along the stream in secs. 28 and 29, T. 35 N., R. 5 E. (Mission Twp.), Marseilles quadrangle; (3) along Brumbach Creek in secs. 1 and 12, T. 34 N., R. 4 E. (Rutland Twp.), Marseilles quadrangle; (4) along Person Creek, south of Marseilles in the NE. ¼ SW. ¼ NW. ¼ sec. 25, T. 33 N., R. 4 E. (Fall River Twp.), Marseilles quadrangle; (5) along the creek south of Seneca in the NE. ¼ SE. ¼ NE. ¼ sec. 35, T. 33 N., R. 5 E. (Brookfield Twp.), Marseilles quadrangle (geol. sec. 48); and (6) along the creek northeast of Seneca in the SE. ¼ NE. ¼ SE. ¼ sec. 13, T. 33 N., R. 5 E. (Manlius Twp.), Marseilles quadrangle.

### *Correlation*

The correlation of the pre-Wisconsin till as Illinoian is based largely on its stratigraphic position. The till has no special characteristics which permit definite correlation with the Illinoian till outside of the area of Wisconsin glacial deposits. However, the distribution of Illinoian drift throughout the State is such that the Marseilles-Ottawa-Streator area must have been covered by the Illinoian glacier as it radiated from the Labradorean center.

The green till that is exposed along Mission Creek east of Serena and in the road-cut a mile south of the Streator quadrangle has the color of old till which in the area and elsewhere in the State has been identified as Kansan. It is nevertheless considered as probably Illinoian because it directly underlies Wisconsin drift.

The calcareous pre-Bloomington till which is present extensively along Fox Valley and along Illinois Valley in the Marseilles quadrangle is correlated with the Illinoian because its compact character and the presence of oxidized joints suggest it is pre-Wisconsin in age, and in these characters it differs from the pre-Bloomington Wisconsin till that is correlated with the Shelbyville drift.

## SANGAMON STAGE[13]

Deposits of peat and peaty silt locally present between the Illinoian and Wisconsin deposits along Fox Valley near Serena, Wedron, and Sulphur Springs probably accumulated during the Sangamon interglacial stage. Throughout much of the area the Sangamon deposits were eroded before the Wisconsin deposits were laid down but extensive deposits may occur in some of the buried bedrock channels.

### *Character*

Along Mission Creek, east of Serena, the Sangamon deposits consist of 3 to 5 feet of noncalcareous silty peat containing many well-preserved fragments of wood (geol. sec. 39 and fig. 89). The upper part of the deposit is largely organic matter and nearly black, but the lower part is very silty and somewhat lighter in color.

At Wedron (geol. sec. 68) the Sangamon deposits consist mostly of dark greenish-gray to brownish-black noncalcareous pebbly silty clay containing a large amount of finely divided organic matter as well as fragments of wood, with local lenses of dark gray calcareous fossiliferous silt, probably loess. At the bottom there is a foot of brown peat. The materials are faintly laminated, and the laminations are contorted. The deposit is probably a mixture of slumped material, slope-wash, and muck which accumulated in a poorly drained swampy depression.

The Sangamon deposits 1½ miles south of Sulphur Springs (geol. sec. 69) consist of 2 feet of noncalcareous peaty silt or soil

[13]Named for Sangamon County, Illinois, where first studied, and because of its conspicuous development in the drainage basin of Sangamon River.
Worthen, A. H., Geology of Sangamon County: Geological Survey of Illinois, vol. 5, p. 307, 1873.
Leverett, Frank, The Illinois glacial lobe: U. S. Geol. Survey Monograph 38, p. 125, 1899.

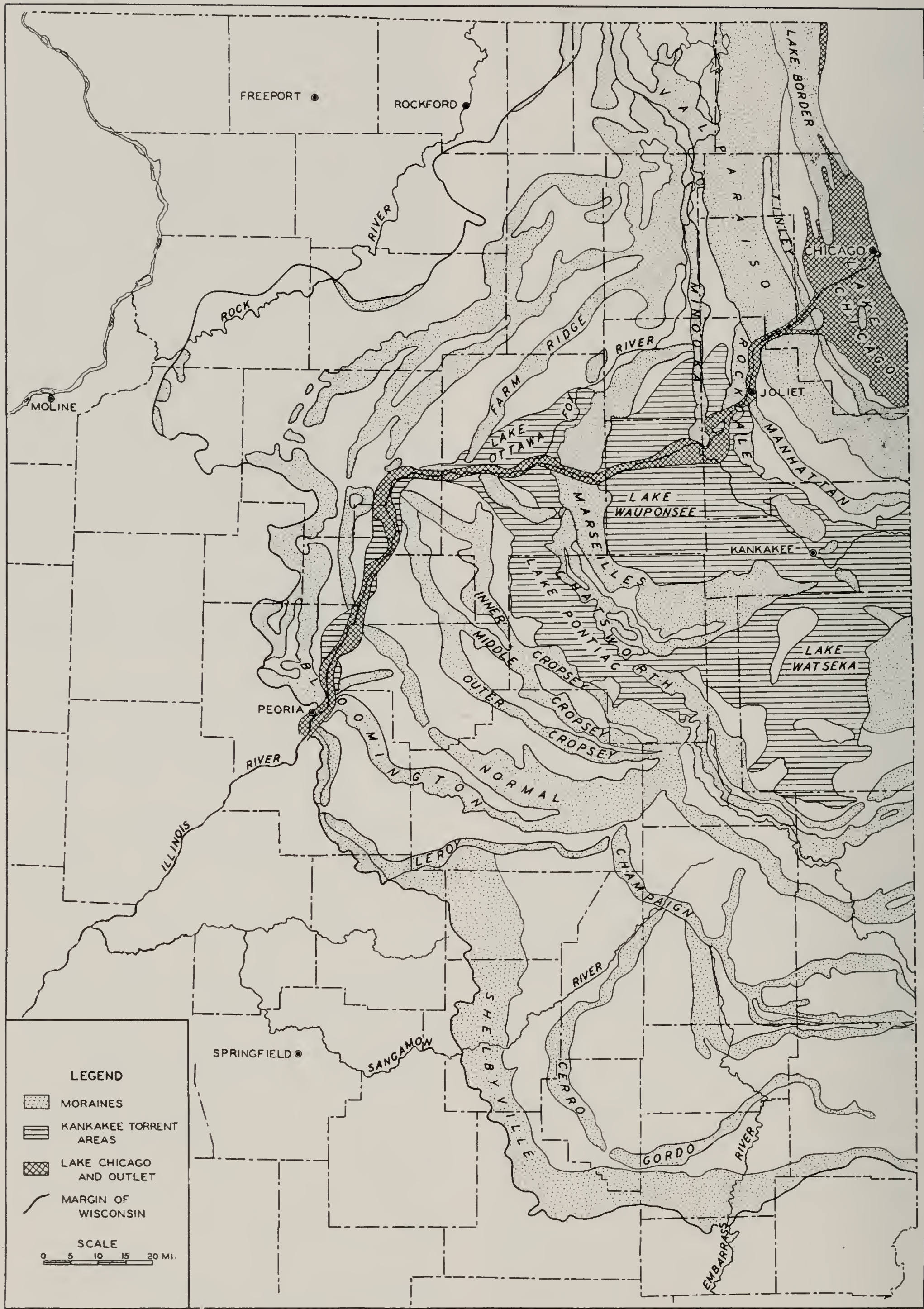


FIG. 90.—Distribution of the glacial deposits of Wisconsin age in Illinois. (Compiled by George E. Ekblaw, Illinois State Geological Survey unpublished map.)

which grades from very dark gray, nearly black, at the top to medium gray at the bottom and overlies 2-4 feet of gray noncalcareous sandy silt and well-sorted medium-grained brown sand, the age of which is uncertain.

### *Correlation*

Peat beds of Sangamon age are present at many places in the LaSalle and Hennepin quadrangles,[14] where they are also overlain by deposits of Wisconsin age, and Sangamon peat and soil is widespread over the Illinoian drift outside the area of Wisconsin glaciation.[15]

## WISCONSIN STAGE[16]

The youngest glacial deposits in the Marseilles-Ottawa-Streator area are of Wisconsin age (fig. 85). They immediately underlie the Recent soil everywhere in all three quadrangles except along the deeper valleys where they have been eroded so that older deposits are exposed. They represent the last three of the four substages —Iowan, Tazewell, Cary, Mankato—into which the Wisconsin stage is subdivided on the basis of the major changes in the movement of the glacier as indicated by the alignment of the various moraines which it built.[17]

All the moraines and associated outwash deposits in the Marseilles-Ottawa-Streator area belong to the Tazewell substage, although over much of the upland areas of all three quadrangles there are lake deposits of clay, silt, sand, and gravel belonging to the Cary substage, and along Illinois Valley there are gravel and sand deposits belonging to the Cary and Mankato substages.

Although the Iowan substage is not represented in the Marseilles-Ottawa-Streator area, only a short distance west, near Princeton,[18] Iowan loess[19] overlies Sangamon deposits and underlies Tazewell drift. If the Iowan loess once extended as far east as the Ottawa or Streator quadrangles it is not now exposed.

## Tazewell Substage[20]

At its maximum extent the Tazewell glacier extended southward and westward well past the middle of Illinois (fig. 90) as indicated by its end-moraine, called the Shelbyville moraine. Its general retreat from its most advanced position consisted of a series of partial retreats and readvances, resulting in the following succession of moraines: Shelbyville, Cerro Gordo - Leroy, Champaign, Bloomington, Normal, Cropsey, Farm Ridge, Chatsworth, Marseilles.

Parts of the Cropsey, Chatsworth, Farm Ridge, and Marseilles moraines occur in the Marseilles-Ottawa-Streator area (pls. 1-3). Of the older Wisconsin drifts the Bloomington is widespread and another correlated with the Shelbyville is locally present in the area.

### SHELBYVILLE DRIFT[21]

The Shelbyville drift consists of (1) till, (2) outwash, and (3) laminated clays, silts, and sands deposited in Lake Kickapoo (p. 157). It overlies the Illinoian till and the Sangamon interglacial deposits and underlies the widespread pink till of Bloomington age. At some places the lake beds are overlain by gravel and sand outwash thought to be of Bloomington age.

The Shelbyville deposits occur principally in preglacial Ticona Valley and crop out at many places along Fox Valley and its tributaries above Dayton, along Illinois Valley east of Marseilles, and at a

[14]Cady, G. H., op. cit. pp. 75-76.

[15]Leverett, Frank, op. cit., pp. 125-130.
Wanless, H. R., Geology and mineral resources of the Alexis quadrangle: Illinois Geol. Survey Bull. 57, pp. 103-104, 1929.
Savage, T. E., and Nebel, M. L., Geology and mineral resources of the LaHarpe and Good Hope quadrangles: Illinois Geol. Survey Bull. 43, pp. 52-55, 1923.
Savage, T. E., and Udden, J. A., Geology and mineral resources of the Edgington and Milan quadrangles: Illinois Geol. Survey Bull. 38, pp. 173-174, 1922.

[16]Named for the State of Wisconsin where the drift is widely distributed.
Chamberlin, T. C., in Geikie, James, The Great Ice Age, Third Edition, pp. 754-774, 1894.
Chamberlin, T. C., The classification of American glacial deposits: Jour. Geology, vol. 3, pp. 270-277, 1895.

[17]Leighton, M. M., The naming of the subdivisions of the Wisconsin glacial age: Science, n.s., vol. 77, No. 1989, p. 168, Feb. 10, 1933.

[18]Cady, G. H., op. cit. pp. 76-77.

[19]Kay, G. F., and Leighton, M. M., Eldoran epoch of the Pleistocene period: Geol. Soc. Am., Bull., vol. 44, p. 673, 1933.

[20]Named for Tazewell County, Illinois, in which the moraines of this substage are well developed. It was formerly designated as "Early Wisconsin."
Leighton, M. M., op. cit.

[21]Named for the town of Shelbyville, Illinois, which is located at the extreme southwest part of the moraine.
Leverett, Frank, op. cit., p. 192.

FIG. 91.—Exposure of Shelbyville gravel and sand overlain by Bloomington and Marseilles till at pit of the Spicer Gravel Company, east of Marseilles, NE. ¼ SE. ¼ NW. ¼ sec. 21, T. 33 N., R. 5 E. (Manlius Twp.), Marseilles quadrangle (geol. sec. 47).

FIG. 92.—Shelbyville outwash gravel exposed in pit south of Seneca, SW. ¼ SE. ¼ SW. ¼ sec. 26, T. 33 N., R. 5 E. (Brookfield Twp.), Marseilles quadrangle.

few scattered localities along Vermilion River. They have a maximum thickness of at least 40 feet near Seneca.

### *Character*

*Till.*—Till is present only locally, usually in the lower part of the Shelbyville deposits. Along Vermilion River about half a mile above Manville Bridge southeast of Streator, the Bloomington till rests on 3 feet of gray till, of which the base is concealed and the upper few inches is slightly leached (geol. sec. 92).[22] Ten feet of gray till overlies the Sangamon deposits a mile south of Sulphur Springs (geol. sec. 69). The till occurs as lenses in gravel and sand or as beds with lenses of sand at several localities near Seneca. It is well exposed near the mouth of the valley south of Seneca (geol. sec. 48).

*Outwash.*—At many places the Shelbyville deposits consist largely of outwash pebbly sand or fine gravel with lenses of sand, usually conspicuously cross-bedded.

The outwash is exposed at many places along the north bluff of Illinois Valley, east of Marseilles. At the pit of the Spicer Gravel Co., 1½ miles east of Marseilles, the deposits are at least 30 feet thick (geol. sec. 47 and fig. 91). The upper part is a fine sandy gravel (app. D, table 6, ML-199), while the lower part is a little coarser (app. D, table 6, ML-200). In a small pit a mile farther east in the NE. ¼ NW. ¼ SW. ¼ sec. 22, T. 33 N., R. 5 E. (Manlius Twp.), Marseilles quadrangle, the material is a pebbly sand (app. D, table 6, ML-196, W-9) with lenses of fine gravel and contains many small till balls.

Shelbyville outwash is especially well developed along the south side of Illinois Valley east of South Kickapoo Creek, where it occurs in the preglacial Ticona Valley. The deposits are predominately sand but gravel is present at several places. Near Farley School, south of Seneca, the deposits underlie the Ottawa Terrace (pl. 1). Gravel exposed in a pit in the SW. ¼ SE. ¼ SW. ¼ sec. 26, T. 33 N., R. 5 E. (Brookfield Twp.), Marseilles quadrangle, is fine to medium (app. D, table 6, W-19) with boulders common in the upper 5 feet (fig. 92). The gravel is reported to be 40 feet thick but is limited to a narrow belt along the edge of the terrace. South of the road the basements of several houses are excavated entirely in sand, which is exposed at the inner edge of the terrace along Spring Brook in the NE. ¼ SW. ¼ NE. ¼ sec. 34. The sand is at least 15 feet thick. It is medium-grained and contains a few streaks of pebbles. The upper 6 feet is rusty-brown and contains a limonitic clay which makes it plastic when wet (table 13). Thirty feet of mostly medium-grained sand (app. D, table 6, W-80) with a few streaks of pebbles is exposed in a pit southeast of the Illinois River bridge at Seneca, in the northwest corner of sec. 36. Deposits of

[22]The geologic sections are given in appendix A.

sand 20 to 40 feet thick are also exposed farther east along Deadly Run and Hog Run, where they locally contain thin beds of silt and are not easily distinguished from the overlying lake deposits.

Along Fox Valley the Shelbyville outwash is generally less than 12 feet thick (geol. secs. 38, 39).

*Lake Kickapoo deposits.*—The most widespread of the Shelbyville deposits in the Marseilles-Ottawa-Streator area are well-stratified lake deposits—silts, sands, and clays—which accumulated in Lake Kickapoo, a temporary glacial lake along Ticona Valley. Lake Kickapoo deposits are usually present where any glacial deposits older than Bloomington are exposed, as along Fox Valley above Dayton, Illinois Valley east of Marseilles, and Vermilion Valley near Kangley. They include part of the deposits previously called "Kickapoo beds,"[23] named for North Kickapoo Creek, east of Marseilles, where they are well exposed.

At many places along Fox Valley near Serena, Wedron, and Sulphur Springs, and along many of the valleys tributary to Fox Valley, especially Indian Creek and Mission Creek (geol. secs. 38, 39, 65, 68, 69), the Lake Kickapoo deposits are largely laminated silt, clayey silt, or silty clay, usually yellow or yellowish-brown, commonly with dark red, pink, and bluish-gray and locally a little white. The laminae are marked by thin streaks of coarse-grained silt or very fine-grained sand, and are parallel and fairly uniform in thickness except where distorted or broken by the overlying till which penetrates the deposits irregularly. Locally, as at Wedron (geol. sec. 68), the deposits occur in a depression in the Illinoian drift, vary in thickness from a trace to 17 feet within 50 feet horizontally, are nonbedded, and contain many large fragments of wood (fig. 93). The maximum thickness of the deposits is the 17 feet at Wedron but at many places they are 6-12 feet thick. The elevation of the top of the deposits generally increases up Fox Valley, from 550 feet above sea-level south of Sulphur Springs to 595 feet along Mission Creek.

Along Illinois Valley east of Marseilles, Lake Kickapoo deposits are well exposed

Fig. 93.—Large fragments of fossil wood in Lake Kickapoo deposits at Wedron (geol. sec. 68).

on the north side in the pit of the Spicer Gravel Company and along North Kickapoo and Carson Creeks, and on the south side along most of the valleys from Person Creek to Hog Run, especially along the valley south of Seneca (geol. sec. 48) and along Deadly Run southeast of Seneca (geol. sec. 49). The deposits are similar to those described along Fox Valley but contain more sand, the laminated clays and silts at some places being split into several units by beds of sand or gravel, especially along Deadly Run. At many places the clays are distorted, and south of Seneca the lower part of the deposits consists of angular fragments of clay in a matrix of sand and silt. Along the south bluff and tributary valleys east of Deadly Run the deposits overlie thick deposits of sand which in part may be lake deposits but more probably correlate with the earlier Shelbyville outwash deposits. The deposits are usually between 5 and 10 feet thick but are locally reduced in thickness or completely removed by erosion prior to deposition of the overlying till. Their top is between 550 and 575 feet above sea-level.

Along Illinois Valley west of Marseilles, Lake Kickapoo deposits are rarely present, but 5 feet of laminated gray and pink silt underlying Bloomington till is exposed

[23]Sauer, Carl O., Geography of the Upper Illinois Valley and history of development: Illinois Geol. Survey Bull. 27, p. 97, 1916.

in a road-cut northwest of Ottawa in the SW. ¼ NW. ¼ NW. ¼ sec. 3, T. 33 N., R. 3 E. (Ottawa Twp.), Ottawa quadrangle.

In the Vermilion River bluffs half a mile north of Kangley (geol. sec. 85) the Bloomington till is underlain by 3 feet of yellow silt at an elevation of approximately 600 feet above sea-level.

### *Correlation*

All the pre-Bloomington Wisconsin deposits in the Marseilles-Ottawa-Streator area are included in the Shelbyville drift. The Shelbyville till is widespread over central Illinois (fig. 90); the outwash is similarly distributed as well as forming numerous valley-trains running far beyond the end-moraine; and lake deposits which probably correlate with the Lake Kickapoo deposits occur at many places farther down Illinois Valley, especially near Spring Valley, Depue, Hennepin, and Peoria.

## BLOOMINGTON DRIFT[24]

Bloomington drift, mostly overlain by Cropsey, Farm Ridge, Chatsworth, and Marseilles drifts (fig. 86), is widely distributed throughout the Marseilles-Ottawa-Streator area, most commonly overlying earlier Wisconsin deposits but in large areas resting directly on bedrock and in some places overlying Sangamon deposits and Illinoian drift. It has a maximum thickness of about 50 feet and consists largely of a characteristic pink till, locally underlain by outwash gravel deposited in front of the advancing glacier and overlain by outwash deposited when the glacier retreated.

### *Character*

*Advance outwash.*—Outwash sand and gravel deposited in front of the advancing Bloomington glacier is locally exposed along Fox Valley at Wedron (geol. sec. 68), farther south along ravines in sec. 16, T. 34 N., R. 4 E. (Dayton Twp.), Ottawa quadrangle, and 1½ miles south of Sulphur Springs (geol. sec. 69). It varies from fine gravel containing lenses of coarse-grained sand to pebbly coarse sand, is cross-bedded irregularly, and is as much as 25 feet thick. It is overlain by Bloomington till.

*Till.*—The Bloomington till crops out at many places along Illinois, Fox, and Vermilion valleys. It is characteristically pink, locally grading to gray both vertically and laterally. In most outcrops the till is uniformly pink from top to bottom and at least some pink till is present in nearly all outcrops. As the pink color is present where excavations are made in the till many feet from the weathered surface and also where the till is both overlain and underlain by gray till, it is evidently original and not the result of oxidation by weathering after deposition of the till. Where moist the till is dark purplish-gray.

The till is usually very sandy. Pebbles are numerous and boulders are present but rarely are abundant. Lenses of sand and gravel locally divide the till into several bands (geol. secs. 38, 39). The till is commonly 5 to 20 feet thick although it is locally 50 feet thick along Indian Creek about two miles north of Wedron. Along Hog Run, southeast of Seneca, it is locally 25 feet thick.

The top of the till is an undulatory surface commonly at an elevation of between 575 and 600 feet above sea-level along Fox Valley and Illinois Valley west of Marseilles but lowering eastward from Marseilles to 525 feet near the east margin of the Marseilles quadrangle.

The till is generally overlain by younger drift (fig. 94), although at a few places in the upland areas both north and south of Ottawa it occurs immediately below the soil and thin loess. It commonly overlies earlier Wisconsin drift except along Illinois Valley west of Marseilles, where it usually rests directly on bedrock.

*Lake Illinois deposits.*[25]—Outwash deposits of the retreating Bloomington ice were laid down in Lake Illinois, which extended along Illinois Valley above the Bloomington moraine at Peoria, at an elevation of approximately 600 feet.

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[24]Named for Bloomington, Illinois, which stands on a prominent portion of the moraine.
Leverett, Frank, op. cit., p. 240.

[25]Named for Illinois Valley by M. M. Leighton; Fisher, D. J., Geology and mineral resources of the Joliet quadrangle: Illinois Geol. Survey Bull. 51, p. 75, 1925.
Leighton, M. M., Lake Illinois and the question of post-early Wisconsin deformation in northern Illinois (abstract): Geol. Soc. America Bull., vol. 39, No. 1, p. 215, 1928.

Along Fox Valley the Bloomington and Farm Ridge tills are commonly separated by a few inches to 10 feet of Lake Illinois deposits (geol. secs. 66, 68). The deposits are usually silt and sand, the silt gray or yellow, laminated at some places, non-bedded at others, the sand fine-grained and in thin horizontal beds. The deposits are commonly 2 to 3 feet but locally 10 feet thick. Along Indian Creek about a mile north of Wedron (geol. sec. 65) 5 feet of coarse, bouldery gravel overlies the Bloomington till at an elevation of about 590 feet and was probably deposited in Lake Illinois although possibly by the advancing Farm Ridge glacier.

Along Vermilion Valley near Manville Bridge (geol. sec. 92) a delta of fine sandy gravel (app. D, table 6, J-8) containing boulders and pink till balls was deposited in Lake Illinois.

Along Illinois Valley in the Marseilles quadrangle Lake Illinois deposits commonly overlie the Bloomington till. They consist mostly of laminated light and dark gray silt and clay with some local fine-grained thin-bedded sand and vary from a few inches to 25 feet thick but are more than 15 feet thick at many places. The deposits are exposed: (1) along a small ravine on north side Walbridge Creek in the NE. ¼ SE. ¼ NW. ¼ sec. 11, T. 33 N., R. 4 E. (Rutland Twp.); (2) in the Spicer Gravel Company pit in the NE. ¼ SE. ¼ NW. ¼ sec. 21, T. 33 N., R. 5 E. (Manlius Twp.) (geol. sec. 47); (3) in a small ravine in the south bluff of Illinois Valley in the SE. ¼ SW. ¼ NE. ¼ sec. 22, T. 33 N., R. 4 E. (Fall River Twp.); (4) along a tributary to South Kickapoo Creek in the NW. ¼ NW. ¼ NW. ¼ sec. 32, T. 33 N., R. 5 E. (Brookfield Twp.); (5) on the west side of the stream in the NE. ¼ SE. ¼ NE. ¼ sec. 35, T. 33 N., R. 5 E. (Brookfield Twp.) (geol. sec. 48); (6) on the east side Deadly Run, NW. ¼ NE. ¼ NE. ¼ sec. 36, T. 33 N., R. 5 E. (Brookfield Twp.) (geol. sec. 49); and (7) along a ravine in the south bluffs of Illinois Valley in the NW. ¼ SE. ¼ NE. ¼ sec. 21, T. 33 N., R. 6 E. (Norman Twp.).

Fig. 94.—Exposure of Farm Ridge till overlying Bloomington till along Covel Creek, SE. ¼ NE. ¼ NE. ¼ sec. 36, T. 33 N., R. 3 E. (South Ottawa Twp.), Ottawa quadrangle.

### *Correlation*

Pink till of Bloomington age is exposed at many places in the upper 50 feet of the Illinois Valley bluffs and along the tributary valleys from the Ottawa quadrangle to the Bloomington moraine at Peoria. It occurs at a fairly uniform elevation and its stratigraphic relations both to the younger and the older drifts can be readily determined. Although the characteristic pink color is important for correlation along Illinois Valley, it is of doubtful value for more distant correlations because the Illinoian till has a very similar color in some areas, as along Illinois Valley near Depue, and because the Bloomington till is gray instead of pink in the eastern part of Illinois.

The till commonly is much more sandy than the overlying tills and at many places can be differentiated from them by that characteristic. It appears to be slightly more sandy and is generally less bouldery than the Illinoian till.

Lake Illinois deposits of Bloomington age occur along Illinois Valley from Peoria upstream at least as far as Morris.

## CROPSEY DRIFT[26]

Cropsey drift underlies a large part of the Streator quadrangle and the north-

[26]Named for the morainic ridge at Cropsey, Illinois, in McLean County.
Leverett, Frank, op. cit., pp. 258-259.

west corner of the Ottawa quadrangle (pls. 2, 3), but only the back slope of the innermost, or youngest, moraine of the Cropsey morainic system occurs in the area, along the west side of the Streator quadrangle. The Cropsey ground-moraine, in part covered with thin deposits of later age, covers the central part and extends to the front of the Farm Ridge and Chatsworth moraines along the north and east sides of the Streator quadrangle. The Cropsey drift may extend below Farm Ridge and Chatsworth drift but there are no outcrops to demonstrate this relation.

*Thickness*

The maximum thickness of the Cropsey drift is probably about 50 feet below some of the higher hills of the moraine along the west margin of the Streator quadrangle near Leonore, but in most of the central part of the quadrangle the drift is usually less than 15 feet thick.

*Character*

The Cropsey drift is largely till, locally both overlain and underlain by outwash deposits of gravel and sand. The outwash from the advancing ice was laid down in Lake Illinois but the deposits from the retreating ice accumulated in a local lake dammed by the Cropsey moraine.

*Lake Illinois deposits.*—The oldest Cropsey deposits consist of gravel and sand laid down in Lake Illinois by melt-water from the advancing Cropsey glacier. They overlie Lake Illinois deposits of Bloomington age and are overlain by Cropsey till. The deposits are only local and are generally less than 10 feet thick (geol. secs. 92, 101).

*Till.*—The Cropsey till is a greenish-gray brown-weathering pebbly silty clay in which boulders are comparatively rare. Lenses of gravel are locally present. The till has a maximum thickness of about 50 feet. It is well exposed along Long Point, Mud, Prairie, Moon, and Otter creeks and elsewhere (geol. secs. 81, 83-85, 90, 92, 93, 101).

*Lake Ancona deposits.*—Melt-water from the retreating Cropsey glacier deposited gravel and sand in a lake lying between the ice-front and the Cropsey moraine and named Lake Ancona for the village of Ancona, five miles southwest of Streator, in the area covered by the lake. Sand, probably deposited in an early high-level stage of the lake, was penetrated in an auger-boring at an elevation of 660 feet about three miles northwest of Long Point (geol. sec. 99). In a later and probably lower stage of the lake several deltas were built at the margin of the ice. A delta exposed in pits southeast of Sandy Ford, near the center of sec. 5, T. 31 N., R. 3 E. (Bruce Twp.), Streator quadrangle, is largely pebbly coarse sand with several beds of gravel, some of which is coarse. Cobbles and till balls are common and a few boulders are present. The material is poorly sorted and angular. The beds dip 15 to 20 degrees a little west of north. The deposit is 5 to 10 feet thick and is overlain by 3 to 5 feet of brown noncalcareous clayey silt containing streaks of pebbles. The top of the gravel has a maximum elevation of about 630 feet. Sand, silt, and clay, probably deposited in Lake Ancona, are exposed along Egg Bag Creek south of Kangley (geol. sec. 86).

Deltal deposits of sand and gravel probably deposited by the retreating Cropsey glacier but possibly of Chatsworth age underlie a large area along Otter Creek, especially in secs. 16 to 21, T. 31 N., R. 4 E. (Otter Creek Twp.), Streator quadrangle. The gravel is commonly 10 to 15 feet but locally as much as 25 feet thick. It varies from coarse to fine, contains lenses and beds of sand, and locally till balls are common. Samples from a pit in the SW. ¼ NW. ¼ NW. ¼ sec. 20 were fine sandy gravel (app. D, table 6, J-16, ML-132). The gravel occurs in beds which dip steeply and uniformly to the northwest, as well exposed in the gravel pit in the SW. ¼ SW. ¼ sec. 17.

Deposits of gravel, sand, and silt overlie Cropsey drift at many other places below an elevation of 650 feet. Although many of these are thought to have been deposited in Lake Pontiac (p. 168), they probably include Lake Ancona deposits as well (especially geol. secs. 92, 97, 98, 100).

*Correlation*

The Cropsey moraines have been traced[27] without notable breaks from the

[27]Ekblaw, George E., personal communication.

Streator area to the type area at Cropsey, about 40 miles southeast of Streator (fig. 90). They were formerly considered as part of the Bloomington morainic system,[28] but are now considered to form a separate system.

### FARM RIDGE DRIFT[29]

Farm Ridge drift underlies most of the Ottawa quadrangle, the north part of the Streator quadrangle, and the northwest part of the Marseilles quadrangle (pls. 2, 3). The Farm Ridge moraine crosses the northwest and southwest corners of the Ottawa quadrangle and the north end of the Streator quadrangle. The Farm Ridge ground-moraine covers a large part of the Ottawa quadrangle, but below an elevation of approximately 640 feet it is covered in places by thin Lake Ottawa deposits (p. 168).

#### *Thickness*

In the Farm Ridge moraine the drift is commonly 30 to 40 feet thick, although in some of the higher hills it may be locally as much as 60 feet thick, and in the ground-moraine it is commonly 5 to 15 feet thick.

#### *Character*

The Farm Ridge drift is largely till but includes sand and gravel, as lenses in the till, in kames, in one large esker, in subglacial channels, and as outwash deposits in front of the moraine and overlying the ground-moraine. Many outwash deposits were laid down as deltas in Lake Illinois during the retreat of the Farm Ridge glacier.

*Till.*—The Farm Ridge till is a medium to light gray, yellowish, or brownish silty clayey till. It is rarely as sandy as the underlying Bloomington till (fig. 94) and is not as clayey although commonly similar to the Marseilles till. Cobbles and boulders are present but rarely abundant. In several outcrops along Fox Valley the lower few feet of the till is almost free from pebbles and is faintly laminated, but is not distinctly separated from overlying typical till. This lower till lies below the level of and was probably deposited in Lake Illinois, which accounts for its unusual character.

*Kames.*—A gravel kame occurs on the Farm Ridge moraine west of Grand Ridge in the NE. ¼ SW. ¼ SW. ¼ sec. 20, T. 32 N., R. 3 E. (Farm Ridge Twp.), Streator quadrangle. Other steep-sided hills in the same area may also contain gravel but kames are not common elsewhere on the moraine.

*Covel Creek esker.*[30]—Sand and gravel interlayered with till underlies an esker about six miles long and 10 to 20 feet high about four miles south of Ottawa (pl. 2). The material is exposed in a railroad-cut at Reed Crossing (geol. sec. 77).

*Frontal outwash.*—Outwash deposits locally occur in front of the Farm Ridge moraine near the northwest corner of the Ottawa quadrangle. About 10 feet of gravel is exposed in a pit in the SW. ¼ SE. ¼ SE. ¼ sec. 16, T. 35 N., R. 2 E. (Ophir Twp.). The gravel is composed mostly of pebbles about one-fourth inch in diameter but contains many large boulders, some 3 feet in diameter. Balls of brown till are common. The upper 1 foot of gravel is weathered and partly leached and is overlain by 6 feet of brown noncalcareous silt.

*Subglacial channel deposits.*—In the northwest part of the Ottawa quadrangle the Farm Ridge moraine is crossed by many channels, mostly subglacial in origin, although perhaps some were modified by melt-water during the retreat of the glacier. Auger borings along several of these channels show they are at least in part underlain by thin deposits of fine gravel and sand (geol. secs. 54, 58). About 8 feet of fine gravel containing a few boulders occurs in a small tract along a channel in the till plain in the NE. ¼ SW. ¼ NE. ¼ sec. 29, T. 35 N., R. 3 E. (Freedom Twp.), Ottawa quadrangle.

*Lake Illinois deposits.*—Many deposits were made in Lake Illinois by the retreating Farm Ridge glacier. They consist of gravel, sand, and silt—the gravel mostly in deltas near and the silt mostly farther from the ice-front.

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[28]Leverett, Frank, op. cit. pp. 243, 258-259.

[29]Named for Farm Ridge postoffice at one time located on a prominent part of the moraine about five miles west of Grand Ridge in Farm Ridge Township.
Leverett, Frank, op. cit., pp. 260-261.

[30]Previously called Covel Ridge. Leverett, Frank, op. cit., p. 288.

Large deltas are exposed along Illinois and Fox valleys (pl. 2), especially north of Starved Rock, south of Ottawa, and near Dayton (geol. secs. 70, 72, 75). They occur in steep-sided channels in glacial drift or in bedrock, and their margins are usually sharply defined even though not evident from the surface. Their thickness varies greatly because of the irregularities of the surface on which they were deposited and because the tops of many of them have been eroded. Few are more than 30 feet thick and many are less than 20 feet thick.

The deposits consist almost entirely of truncated foreset beds dipping westerly 10-30, usually about 20 degrees. The beds are fairly uniform individually but different beds vary from a fraction of an inch to a foot or rarely several feet in thickness. The size of the material also varies widely and beds of coarse, medium, and fine gravel and sand are interlayered. Many deposits are approximately half sand and half gravel, with a highly variable amount of cobbles and boulders (app. D, table 6, ML-130, ML-176, ML-177, ML-181, ML-182, ML-194, ML-198, W-2, W-5, W-7, W-18). The material contains more disseminated clay and silt than is found in other gravel outwash deposits and is generally poorly sorted, but some beds are well sorted and most deposits are characterized by beds composed largely of pebbles ¼-½ inch in size. Beds of laminated brownish-gray silt occur locally, and in a pit a mile southwest of South Ottawa (geol. sec. 72) a silt bed 8-14 inches thick occurs at a fairly uniform elevation about 10 feet below the top of the deposit and is both overlain and underlain by sandy gravel.

The pebbles range from angular to well-rounded. Most of them are limestone and dolomite but there is a considerable quantity of local bedrock, especially the Pennsylvanian shales and sandstones, and chert and igneous and metamorphic rocks are common. Some of the igneous rocks, in particular a coarse-grained dark brown peridotite, have been so softened by weathering that they can be crushed by hand. Balls of gray till, like Farm Ridge till, are common in nearly all of the deposits but have not been found in the deposit southwest of South Ottawa.

*Correlation*

The Farm Ridge moraine has been correlated with the Chatsworth moraine[31] but the presence of a foss between the moraines in the northeast corner of the Streator quadrangle and the general trend of the ridges along the crest of the Chatsworth moraine across the projected trend of the Farm Ridge moraine indicate that they are not equivalent and that the Chatsworth is younger. However, it is probable that the difference in age is slight.

Several of the Lake Illinois deltas along the east side of Fox Valley are so near the front of the Marseilles moraine that they could have been formed by Marseilles outwash, but other considerations lead to the belief that they are of Farm Ridge age.

### CHATSWORTH DRIFT[32]

The Chatsworth drift occurs only as a moraine along the east side of the Streator quadrangle (pl. 3), in which the drift is probably as much as 40 feet thick in some of the higher hills and appears to be largely till. Some of the gravel along Otter Creek near the front of the moraine may be Chatsworth outwash (p. 160).

### MARSEILLES DRIFT[33]

Marseilles drift underlies most of the Marseilles quadrangle and the east side of the Ottawa quadrangle (pls. 1, 2). The Marseilles moraine forms a broad ridge east of Fox River, and the ground-moraine covers the area east of the moraine. At many places the Marseilles drift below an elevation of 640 feet is covered by thin Kankakee Torrent deposits of silt, clay, sand, and gravel (p. 167).

*Thickness*

The Marseilles drift has a maximum thickness of about 200 feet beneath the

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[31]Leverett, Frank, op. cit., p. 260.
Leighton, M. M., and Ekblaw, G. E., in Glacial geology of the Central States, Int. Geol. Cong., XVI session, Guidebook 26, p. 17, 1932.

[32]Named for the village of Chatsworth, which is located on the moraine, in southeastern Livingston County.
Leverett, Frank, op. cit. p. 259.

[33]Named for the town of Marseilles which is situated at the place where Illinois River cuts through the moraine.
Leverett, Frank, op. cit., p. 307.

higher parts of the moraine north of Marseilles, and in a large part of the moraine it is at least 100 feet thick. The principal variations in thickness of the Marseilles drift result from the irregular top of the drift. The base of the Marseilles drift as exposed along Illinois Valley declines from approximately 600 feet on the west side of the moraine to about 550 feet at the east side of the Marseilles quadrangle, with local variations as much as 20 feet.

### *Character*

The Marseilles drift is largely till, but gravel and sand is present in kames and eskers, as deposits in subglacial channels, as outwash-plains in front of the moraine, as deltas in Lake Illinois and Lake Lisbon, and as deposits of the Fox River Torrent.

*Till.*—The Marseilles till is exposed at many places in the Marseilles quadrangle in the Illinois Valley bluffs and tributary ravines and along many of the Fox River tributaries which head in the moraine. The till is gray to dark gray, with a greenish cast, and is usually more clayey than any other till in the area, being very sticky when wet. Cobbles and boulders are present but rarely abundant. Pebbles are common except in the lower few feet which in many places is almost entirely clay and locally is faintly bedded.

*Kames and eskers.*—Kames and eskers are not common on the Marseilles moraine. A small esker south of Marseilles in the NW. ¼ NW. ¼ sec. 8, T. 32 N., R. 5 E. (Brookfield Twp.), Marseilles quadrangle, is a low indistinct ridge of gravel under a thin cover of till. The gravel is at least 35 feet thick locally. It varies from fine to medium, is subangular, and is cross-bedded in various directions. It contains beds of pebbly clay and balls of gray till. The 8 feet of gravel exposed above water-level is a fine sandy gravel (app. D, table 6, W-13).

Some of the steeper hills along the crest of the moraine may be kames but no gravel pits have been opened to prove them. Auger borings show gravel is present at least locally in some of the kame-like hills south of Marseilles in the NE. ¼ sec. 6, T. 32 N., R. 5 E. (Brookfield Twp.), Marseilles quadrangle.

FIG. 95.—Evenly bedded fine gravel and sand containing thin beds of silt—Marseilles outwash in gravel pit along south side of Brumbach Creek, NW. ¼ sec. 18, T. 34 N., R. 5 E. (Miller Twp.), Marseilles quadrangle.

*Subglacial channel deposits.*—The broad subglacial channels along the front of the moraine locally contain gravel usually less than 3 feet thick, but the existence and extent of the gravel deposits are rarely evident at the surface. However, the large subglacial channel occupied by Brumbach Creek contains gravel deposits in secs. 17, 18, T. 34 N., R. 5 E. (Miller Twp.), sec. 13, T. 34 N., R. 4 E. (Rutland Twp.) Marseilles quadrangle (fig. 95), and in parts of adjacent sections. The deposits are at least 40 feet thick locally but are generally thinner. The gravel is fine and sandy (app. D, table 6, W-8) with pebbles up to 3 inches in diameter, and occurs in thin uniformly parallel, horizontal beds. There are many beds of coarse sand, and beds of sandy silt 2 inches to 1 foot thick are locally common.

FIG. 96.—Deltal foreset beds of Lake Illinois gravel deposit in pit northeast of Seneca, SW. ¼ NW. ¼ NW. ¼ sec. 8, T. 33 N., R. 6 E. (Erienna Twp.), Marseilles quadrangle.

*Frontal outwash.*—Outwash deposits of gravel more or less continuous with the subglacial channel deposits and similar in character to those along Brumbach Creek are present along many of the valleys tributary to Fox River and Covel Creek and originating on the Marseilles moraine.

*Lake Illinois deposits.*—Gravel deltas similar to those formed by the Farm Ridge glacier were deposited in Lake Illinois by melt-water from the retreating Marseilles glacier (fig. 96). Deltas occur at many places along both sides of Illinois Valley in the Marseilles quadrangle and extend east of the moraine at least as far as three miles east of Seneca (pl. 1). They are exposed: (1) on the east side of the Spicer Gravel Company pit, NW. ¼ SW. ¼ NE. ¼ sec. 21, T. 33 N., R. 5 E. (Manlius Twp.) (geol. sec. 47)[34]; (2) northeast of Seneca along Stanton Creek, SW. ¼ NW. ¼ NW. ¼ sec. 8, T. 33 N., R. 6 E. (Erienna Twp.), (app. D, table 6, ML-195, W-20); (3) in a road-cut and gravel pit along the highway, NE. ¼ SE. ¼ SE. ¼ sec. 8, T. 33 N., R. 6 E. (Erienna Twp.); (4) south of Seneca, SW. ¼ SW. ¼ NW. ¼ sec. 36, T. 33 N., R. 5 E. (Brookfield Twp.), (app. D, table 6, W-12); and (5) southeast of Seneca, SW. ¼ SW. ¼ NE. ¼ sec. 31, T. 33 N., R. 6 E. (Norman Twp.) (app. D, table 6, W-11).

*Lake Lisbon deposits.*—Part of the Marseilles quadrangle near the northeast corner (pl. 1) was covered by a temporary lake between the Marseilles moraine and the front of the retreating Marseilles glacier and it is named Lake Lisbon for the village of Lisbon, in southwestern Kendall County, which is located in the area covered by the lake. The maximum elevation of the lake was about 700 feet, but it was continually lowered as the outlet channels through the moraine were deepened and consequently no beach features were developed.

The principal deposit in Lake Lisbon is an ice-front delta ridge called Central Ridge (fig. 106). It is about two miles long in the Marseilles quadrangle (pl. 1), but extends northeastward for nine miles and is well developed near the village of Central in the Morris quadrangle. It is

[34]The geologic sections are given in appendix A.

about a quarter of a mile wide, generally less than 15 feet high, and varies in elevation from about 600 feet in the Marseilles quadrangle to 630 feet a few miles east. The material in the ridge is exposed in a pit in the NW. ¼ NW. ¼ SE. ¼ sec. 15, T. 34 N., R. 6 E. (Nettle Creek Twp.), Marseilles quadrangle, where it is composed of fine sandy gravel (app. D, table 6, W-10) in bands of medium and fine gravel and coarse sand with several 1- to 2-inch beds of silt and a few cobbles.The beds have a 10-degree dip uniformly northwest. The gravel is at least 12 feet thick and is overlain by 3 to 4 feet of noncalcareous brown silt.

Deposits of silt and sand occur locally in the part of Lake Lisbon that lay at an elevation between 650 and 700 feet (geol. secs. 35, 37). Silt deposits are common in the part of the lake below 650 feet, but they were probably deposited in the later Lake Wauponsee (p. 167).

*Fox River Torrent deposits.*[35]—Deposits of gravel which locally occur in shallow depressions in the upland near Wedron at an elevation of 600 to 620 feet (geol. secs. 38, 39, 68, 69) are believed to have been made by the Fox River Torrent, which resulted from the concentration of a large volume of water into the upper Fox Valley when the Marseilles glacier began to retreat. In the Marseilles and Ottawa quadrangles the torrent entered Lake Illinois at an elevation of 600 feet and assumedly raised the local level of the lake until it overflowed part of the upland flat north of Ottawa where the deposits occur. The deposits, locally 10 feet thick but usually thinner, are largely fine sandy gravel (app. D, table 6, ML-133) but contain cobbles at a few places.

### *Correlation*

The Marseilles moraine continues north and east from Marseilles until overridden by the Minooka moraine near Yorkville (fig. 90). North of Elgin the Minooka moraine is in turn overridden by the West Chicago moraine from beneath which the Marseilles, formerly known as the Kishwaukee moraine, emerges a little farther north with an extensive frontal outwash-plain formed by the Fox River Torrent[36].

The moraine continues south and east from Marseilles to near the Illinois-Indiana state line in the northeast part of Iroquois County, where it is overridden[37] by a younger moraine, the Iroquois, which was formerly correlated with the Marseilles.[38]

Interpretation of the gravel deposits in the upland areas near Wedron as of Fox River Torrent age is somewhat uncertain because the area was later covered by Lake Ottawa of Kankakee Torrent age, but the volume of water in Fox Valley was probably much larger at the time of the Fox River Torrent and therefore more likely to have deposited the gravel.

## TAZEWELL LOESS

The Tazwell moraines and ground-moraines are mantled by loess-like silt that is mostly loess modified by weathering. Most of the loess accumulated during the Tazewell substage with some added during later Wisconsin and Recent times. Weathering of the loess which began immediately after its deposition, has continued to the present.

### *Thickness*[39]

The loess, including the surficial humus soil, is composed mostly of silt with variable quantities of organic matter, is commonly 3 to 4 feet thick, and is rarely over 6 feet thick. It is usually thicker in depressions than on higher areas but not appreciably so except in hilly tracts. The thickest loess occurs in the northwest part of the Ottawa quadrangle, where it is 5 to 6 feet thick at a number of places and is locally 8 feet thick. Near the base of the frontal slope of the Farm Ridge moraine there is 13 feet 6 inches of loess-like silt (geol. sec. 53) which may include some

[35]Named for Fox River. Leighton, M. M., Powers, W. E., and MacClintock, Paul, Geology and Mineral Resources of the Elgin, Geneva, and Barrington quadrangles: Illinois Geol. Survey, report in preparation.

[36]Leighton, M. M., Powers, W. E., and MacClintock, Paul, op. cit.

[37]Ekblaw, George E., personal communication.

[38]Leverett, Frank, The Pleistocene of Indiana and Michigan: U. S. Geol. Survey Monograph, vol. 53, pp. 126-128, 1915.

[39]The thickness of the loess was determined largely by auger borings made far enough from valleys that the thickness of the loess had been little if any reduced by erosion. The values so determined are consistent with the thickness in most of the outcrops, especially those that extend to the level of the upland and are kept fresh by undercutting of the streams, so that they are affected neither by erosion nor by slumping.

slope-wash. Where the loess and underlying till are both weathered, the boundary between the two is not sharp but gradational through a zone usually less than 6 inches thick.

On the Cropsey ground-moraine the loess is 1½-4 feet thick, on the Farm Ridge drift it is 3-10, usually 4-6, feet thick, and on the Marseilles moraine it is 2-3½, usually 2½-3, feet thick. On the tops of many of the higher hills of the moraines the loess is either absent or is represented only by ½-1 foot of silty soil.

### *Character*

The loess is largely a uniform brown or dark brown or locally gray or brownish-yellow nonbedded clayey silt or silty clay, the slight variations in texture probably resulting from removal or concentration of clay by percolating waters although possibly partly original. The loess is nearly all noncalcareous. Calcareous loess was not found in outcrops but was found in a few auger borings (geol. secs. 51, 54, 57, 99).

A band of black noncalcareous or locally slightly calcareous silt 2 inches to 3 feet thick occurs locally at or near the base of the loess in the northwest part of the Ottawa quadrangle and was penetrated in several auger borings on the ground-moraine (geol. secs. 51, 52), in subglacial channels (geol. sec. 54), and in the low flat in front of the Farm Ridge moraine (geol. secs. 53, 56, 57), but it was not found on any of the morainic hills. It contains a large amount of organic matter which gives it a mucky odor. Its texture is similar to that of the loess but it locally contains a few small pebbles. Whatever loess occurs below the black silt is generally calcareous.

### *Correlation*

The greater part of the loess was evidently deposited before there was any appreciable weathering of the underlying till, as all of the till is calcareous wherever the lower part of the loess is calcareous, but some of the upper part was probably deposited during the Cary substage. However, the thinness of the loess on the later moraines east of the Marseilles-Ottawa-Streator area and on the Chicago Outlet River terraces in the area indicates that the later deposits were relatively small.

An even smaller amount of the loess has no doubt been added by Recent dust-storms. In the great dust-storms of 1934 and 1935, large volumes of dust were carried into the area but the average thickness of the material deposited is indistinguishable. As this dust was derived from the western plains laid bare by combined drought and destruction of vegetation by tillage and over-grazing, such dust-storms probably were not characteristic of all of Recent time.

As the loess on the Farm Ridge moraine is 1 to 2 feet thicker than on the Marseilles moraine, probably that amount of loess was deposited after the Farm Ridge moraine was built and before the deposition of the Marseilles moraine. The thin black silt that locally occurs 1 to 2 feet above the base of the loess on the Farm Ridge moraine may mark the break between the pre-Marseilles and the post-Marseilles loess.

Probably most if not all of the Tazewell loess that was originally deposited on the areas that were later occupied by the Kankakee Torrent lakes was reworked by the lakes, and so if any of the original loess remains, it is represented in the basal part of the lake silts.

The noncalcareous loess closely resembles physically the surficial silt of a mature soil profile on glacial drift, but the soil profile in the Marseilles-Ottawa-Streator area is immature and the silt therefore could not be derived from the underlying deposits by weathering.

## Cary Substage[40]

The only deposits of Cary age in the Marseilles-Ottawa-Streator area are those made by the melt-water derived from the glaciers when they occupied regions northeast of the area and built a succession of moraines of which those in northeastern Illinois are respectively, from oldest to youngest, Minooka, Rockdale, Valparaiso, Tinley, and Lake Border. The deposits

[40]Named for the village of Cary in McHenry County, Illinois, which is located on a prominent part of the Valparaiso morainic system. The substage was formerly called "Middle Wisconsin."

Leighton, M. M., The naming of the subdivisions of the Wisconsin glacial age: Science, n.s., vol. 77, no. 1989, p. 168, Feb. 10, 1933.

in this area are related to Valparaiso and later times. Melt-water from the Minooka glacier flowed down Illinois and Fox valleys and that from the Rockdale glacier also flowed down Illinois Valley, but any deposits that they made have been subsequently eroded or are indistinguishable from other deposits.

### VALPARAISO DRIFT[41]

The Valparaiso deposits in the Marseilles-Ottawa-Streator area are materials which were transported along Illinois, Fox, and Vermilion valleys by melt-waters from the glacier. Along Illinois and Vermilion valleys the deposits were mostly made by the Kankakee Torrent early in Valparaiso times, but those along Fox Valley, which are found in the Serena and Wedron terraces, are believed to be slightly later Valparaiso outwash.

### KANKAKEE TORRENT DEPOSITS[42]

Preceding and during the culmination of the Valparaiso glacier, melt-water from a great expanse of ice in Michigan, Indiana, and Illinois was concentrated into Kankakee Valley, thus forming the Kankakee Torrent. Melt-waters from smaller areas of the glacier in Wisconsin and Illinois joined the Torrent by way of the DesPlaines and Fox valleys. At its maximum extent the enormous volume of water overflowed the valleys, which were much shallower and narrower than at present, and spread over the upland tracts between the morainal ridges to form Lake Wauponsee in Illinois, Kankakee, and DesPlaines valleys, Lake Ottawa in Illinois and Fox valleys, and Lake Pontiac in Vermilion Valley (fig. 90). Deposits in these lakes consist largely of clay and silt, locally with sand and gravel. As the volume of water decreased, Lakes Ottawa and Pontiac disappeared and in their areas the water was confined to channels which it eroded to successively lower levels and along which it locally deposited sand and gravel. At the same time Lake Wauponsee, which was slightly higher and much deeper than the other lakes, was lowered to a level called Lake Morris, and Illinois Valley below the lake was eroded to the level of the Buffalo Rock terrace, the lowest erosional level of the Kankakee Torrent.

*Character*

*Lake Wauponsee Deposits.*—Much of the extensive area lying between the Marseilles and Minooka moraines, and known as the Morris basin, was covered by the Kankakee Torrent to form a lake for which the name Wauponsee is proposed, after the village of Wauponsee which is located on the lake flat about seven miles southwest of Morris. All of the basin now below an elevation of about 650 feet, including about 60 square miles along the east side of the Marseilles quadrangle (pl. 1), was inundated by the lake.

Lake deposits underlie much of the area covered by the lake, especially in the area below an elevation of 620 feet, but at many places, especially in the area between the 620-foot elevation and the shoreline, they are absent and Marseilles till lies immediately below the soil. The shoreline is indistinct and beach deposits have not been found.

The deposits, which range from a few inches to 6 feet but are usually less than 4 feet thick, are mostly silt, laminated at some places, nonbedded at others, and variably gray, yellow, and brown. Thin beds of clay are common in the laminated deposits. Beds of sand are present at many places and thin beds of sandy gravel are locally present. The deposits are well exposed along Nettle Creek downstream from the center of sec. 29, T. 34 N., R. 6 E. (Nettle Creek Twp.), Marseilles quadrangle (geol. secs. 42-44[43]), and along Hog Run in secs. 4 and 5, T. 32 N., R. 6 E. (Vienna Twp.), Marseilles quadrangle. They have been encountered in auger borings at many places (geol. secs. 41, 45, 46).

*Lake Morris deposits.*[44]—During the recession of the water from Lake Wau-

[41]Named by L. C. Wooster for the town of Valparaiso, Indiana, which is situated on the moraine.
Leverett, Frank, The Illinois glacial lobe: U. S. Geol. Survey, Mon. 38, p. 339, 1899.

[42]Named for Kankakee Valley.
Ekblaw, George E., and Athy, L. F., Glacial Kankakee Torrent in northeastern Illinois: Geol. Soc. America Bull., vol. 36, pp. 417-428, 1925.

[43]The geologic sections are given in appendix A.

[44]Named for the town of Morris which is located in the area covered by the lake.
Culver, H. E., Geology and mineral resources of the Morris quadrangle: Illinois Geol. Survey Bull. 43, pp. 154-155, 1923.

ponsee its level was maintained at 560 feet long enough to produce local beaches, and this stage has been called Lake Morris. In the Marseilles quadrangle Lake Morris covered only a small area along the east margin of the quadrangle east of O'Brien Run, between the elevations of 540 and 560 feet (pl. 1, fig. 108), where the lake had its outlet into Illinois Valley.

This small area is largely underlain by till, but 3 feet of fine gravel consisting largely of limestone pebbles and overlain by 18 inches of soil and weathered gravel is exposed at an elevation slightly below 560 feet along O'Brien Run in the NE. ¼ SW. ¼ NE. ¼ sec. 2, T. 33 N., R 6 E. (Erienna Twp.), Marseilles quadrangle.

*Lake Ottawa deposits.*—The Kankakee Torrent also covered much of the area between the Marseilles and Farm Ridge moraines in the Ottawa, Marseilles, and Streator quadrangles to form a lake for which the name Ottawa is proposed, after the city of Ottawa which is located in the area covered by the lake. At its maximum extent Lake Ottawa had an elevation of about 640 feet and covered an area of approximately 200 square miles in these quadrangles (pls. 1-3).

The area covered by the lake is mantled by 3 to 4 feet of soil and noncalcareous weathered loess-like silt, below which lake deposits of silt, sand, and gravel, generally less than 5 feet thick, are very irregularly distributed. Their distribution is not reflected in the topography.

In the upland north of Illinois Valley, Lake Ottawa deposits are exposed at few places and are known principally from auger borings (geol. secs. 60, 62, 63). They are mostly yellow, gray, or brown silt with thin beds of sand and clay. A few inches of gravel is locally present along some of the broad shallow channels which cross the upland. A small deposit of fine gravel about 5 feet thick occurs along the stream in the SW. ¼ NW. ¼ SW. ¼ sec. 15, T. 34 N., R. 2 E. (Waltham Twp.), Ottawa quadrangle. Some of the thin gravel and sand deposits which underlie the loess-like silt at the top of the bluffs along Indian Creek and Fox Valley north of Wedron are possibly of Kankakee Torrent age although more probably formed by the Fox River Torrent of Marseilles age (p. 165).

South of Illinois Valley, Lake Ottawa deposits of gravel, sand, and silt were penetrated in auger borings in an extensive area between Ottawa and Covel Creek (pl. 2, geol. secs. 71, 73, 74). Where the deposits are gravel only a few inches was penetrated in the auger-borings, but where sand was encountered, 3 to 5 feet was penetrated without reaching the base. A boring half a mile east of Mud College penetrated 8 feet 6 inches of nonbedded gray silt, and another a mile farther east penetrated 5 feet of gray silt with thin streaks of sand and gravel.

The gravel was formerly exposed in a pit in the NE. ¼ NE. ¼ NE. ¼ sec. 19, T. 33 N., R. 4 E. (Fall River Twp.), Ottawa quadrangle, and is reported to have a delta structure with the beds dipping south. The deposits are probably less than 10 feet thick. To the west they appear to extend to and perhaps overlie a Lake Illinois delta of Farm Ridge age.

Several small oval mounds about 100 feet long, which auger-borings indicate are composed of gravel, occur in the SW. ¼ SE. ¼ SW. ¼ sec. 22, T. 32 N., R. 4 E. (Grand Rapids Twp.), Streator quadrangle (geol. sec. 76), at the north end of a narrow channel through the Farm Ridge moraine and probably represent bars formed by the waters flowing from Lake Pontiac into Lake Ottawa.

*Lake Pontiac deposits.*—The Kankakee Torrent also covered much of the Vermilion River Valley between the Cropsey, Farm Ridge, and Chatsworth moraines to form a lake called Lake Pontiac, after the town of Pontiac which is located on the lake plain. All of the basin below an elevation of 650 feet, including an area of approximately 125 square miles in the Streator quadrangle, was inundated (pl. 3).

Lake deposits underlie much of the area of the Streator quadrangle covered by Lake Pontiac (geol. secs. 80, 82, 85, 86, 91, 94, 96-98, 100-102), although at many places they are absent and till occurs immediately below the surficial soil and loess-like silt. The lake beds are more uniformly present in the channeled areas below an elevation of 620 feet (fig. 107).

They are exposed at the top of the bluffs along many of the valleys and have been penetrated in the lake plain by many auger borings which show they are locally as much as 12 feet but are usually less than 3 feet thick. They consist chiefly of yellow laminated silt interbedded with sand, but a little gravel is locally present. Along the outlet channel of Lake Pontiac in the northwest part of the Streator quadrangle, gravel occurs in low ridges, probably bars, below an elevation of 650 feet and above 610 feet, especially in secs. 22 and 23, T. 32 N., R. 2 E. (Vermilion and Deer Park Twps.), Streator quadrangle.

*Deposits in High-level Channels.*—Thin deposits of gravel and sand occur at a few places along the bottoms of the channels which the Kankakee Torrent eroded along Illinois Valley in its receding stages. Several broad, shallow channels were eroded along the north side of the valley west of Ottawa at successively lower levels between the bottom of Lake Ottawa and the top of the Buffalo Rock terrace, and channels at the same levels are locally present on the south side of the valley (pl. 2). A small but distinct terrace related to these channels occurs at an elevation of about 570 feet near the middle of the west line of sec. 22, T. 33 N., R. 3 E. (South Ottawa Twp.), Ottawa quadrangle. As these features are erosional, they are underlain by deposits older than the Kankakee torrent except for the local sand and gravel deposits.

*Buffalo Rock Terrace deposits.*—Remnants of the Buffalo Rock terrace, named for Buffalo Rock whose top surface is one of the terrace remnants, occur along Illinois Valley at an elevation ranging from 540 to 570 feet but usually only slightly above 540 feet. Gravel and sand underlies several of the terrace remnants but as the terrace surface is principally an erosional level many of them are underlain by bedrock or till.

(1) Gravel, sand, and silt underlie most of a terrace remnant about 1½ miles long on the north side of Illinois Valley two miles east of Ottawa (pl. 2). The terrace surface is from 40 to 70 feet above the valley-floor and slopes from an elevation of about 570 feet at the east end

Fig. 97.—Concentration of boulders from the basal Kankakee Torrent deposits uncovered along O'Neill Branch, east of Ottawa, SE. ¼ SW. ¼ SW. ¼ sec. 4, T. 33 N., R. 4 E. (Rutland Twp.), Ottawa quadrangle.

to about 540 at the west end. The deposits have a maximum thickness of about 25 feet near the east end of the terrace where they lie on till, but thin to the west where they lie on an uneven bedrock surface that becomes higher westward and forms the westernmost part of the terrace.

The base of the deposits consists of boulders, some of which are 3 feet in diameter (fig. 97), in a bed locally 5 feet thick but usually thinner. The boulders are overlain by gravel highly variable in texture but generally coarsest along the outer margin of the terrace. Gravel exposed along the paved highway along the south side of the terrace is coarse and poorly sorted (app. D, table 6, DX-11) but in outcrops along O'Neill Branch and in a pit in the NW. ¼ SW. ¼ SW. ¼ sec. 4, T. 33 N., R. 4 E. (Rutland Twp.), Ottawa quadrangle, it is fine-grained and has numerous lenses of cross-bedded sand (app. D, table 6, W-16). Three feet of brownish-gray calcareous silt, overlying 1 foot of brown coarse sand, in turn overlying 3 feet of nonbedded dark bluish-gray calcareous silt, is exposed along the north tributary of O'Neill Branch in NE. ¼ NE. ¼ SE. ¼ sec. 5, near the north side of the terrace. A similar succession was encountered in an auger-boring half a mile farther northwest.

Angular to subangular fragments of the sandstone, shale, "slate," and coal beds exposed in the Illinois Valley bluffs east of the terrace are abundant, comprising commonly less than 25 per cent but locally as much as 50 per cent of the deposit. They are less common in the finer gravel and sand deposits, although streaks of small coal fragments are present along the bedding-planes in the sand deposits. The pebbles of limestone, dolomite, and igneous rocks which commonly form the bulk of the gravel deposits are subangular to well rounded.

(2) A small remnant of the Buffalo Rock terrace occurs on the west side of Fox River near the center of sec. 6, T. 33 N., R. 4 E. (Ottawa Twp.), Ottawa quadrangle, and is underlain by fine to medium gravel 10 to 15 feet thick, locally with a few feet of medium-grained sand at its base, all overlying bedrock.

(3) Another terrace remnant occurs along the north bluff of Illinois Valley, in the NE. ¼ NE. ¼ sec. 1, T. 33 N., R. 3 E., and NW. ¼ NW. ¼ sec. 6, T. 33 N., R. 4 E. (Ottawa Twp.) Ottawa quadrangle. The materials composing the terrace are poorly exposed but at one place the upper 10 feet of the deposit is a fine sandy gravel containing thin beds of silt and lenses of sand (app. D, table 6, W-17), which is reported to overlie a thick deposit of sand. At least the lower part of these deposits is probably older than the Kankakee Torrent and the surface of the terrace may be an erosional level.

(4) Most of the residential district of South Ottawa is located on a remnant of the Buffalo Rock Terrace whose surface slopes westward from about 570 feet above sea-level near the east end to about 540 feet at the west end. The terrace is underlain by till in some places and by bedrock in others, with a little gravel or sand present locally near the west end and with boulders common over much of the surface.

(5) The surface of Buffalo Rock is locally underlain by 3 to 4 feet of stratified sand, some of which has been blown into small dunes. It is exposed at the top of the quarry in the SE. ¼ NE. ¼ SE. ¼ sec. 18, T. 33 N., R. 3 E. (Ottawa Twp.), Ottawa quadrangle.

*Correlation*

The Kankakee Torrent is correlated with the maximum advance and early stages of retreat of the Valparaiso ice-sheet.[45] Benches and channels at and below an elevation of about 640 feet along the top of Illinois Valley bluffs in the LaSalle and Hennepin quadrangles were probably eroded by the water flowing from the large lakes formed by the torrent in the Marseilles-Ottawa-Streator area. The surfaces of large terraces at Hennepin, Henry, Chillicothe, and other places farther down Illinois Valley are largely the consequence of erosion by the torrent.

### SERENA TERRACE DEPOSITS

The Serena terrace, named for Serena township in the northwest part of the Marseilles quadrangle where the terrace is well developed, occurs along Fox Valley (pls. 1, 2) at an elevation of about 590 feet at the north side of the Marseilles quadrangle but decreases to about 540 feet near the mouth of Fox Valley. In the Marseilles quadrangle the terrace is generally underlain by valley-train deposits of sand and gravel but farther down the valley it is largely erosional, with only thin local deposits of gravel and boulders.

*Character*

(1) A remnant of the Serena terrace along the north side of the Marseilles quadrangle west of Fox River Academy and north of Mission Creek is underlain by gravel outwash. Where exposed in a pit in the SW. ¼ SW. ¼ NE. ¼ sec. 20, T. 35 N., R. 5 E. (Mission Twp.), Marseilles quadrangle, the deposits consist of about 15 feet of well-sorted horizontally bedded fine gravel containing many well-rounded 1-inch pebbles (app. D, table 6, W-6). Many boulders occur in the base of the deposit, which rests on bedrock. The deposit is overlain by 3 to 4 feet of brown silt and soil, except for a few local dunes of fine sand which are as much as 10 feet high.

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[45]Ekblaw, George E., and Athy, L. F., Glacial Kankakee Torrent in northeastern Illinois: Geol. Soc. America Bull., vol. 36, pp. 417-428, 1925.

(2) The largest remnant of the Serena terrace occurs on the west side of Fox River a short distance downstream from the one described above. It is 2½ miles long and ¼ mile wide and varies in elevation from about 590 feet at the north end to 570 feet at the south end. The surface is undulatory, with distinct channels and a few bar-like ridges. The deposits underlying the terrace are thin, especially in the north part where they are less than 2 feet thick in some places, but 10 to 15 feet of gravel is present locally. Fine gravel is exposed in a pit in a bar-like ridge on the terrace in the NE. ¼ NW. ¼ SE. ¼ sec. 30, T. 35 N., R. 5 E. (Serena Twp.), Marseilles quadrangle, (app. D, table 6, W-1). Near the mouth of the stream crossing the terrace in the NE. ¼ NE. ¼ SE. ¼ sec. 30, the gravel is 6 feet thick and is coarser than elsewhere, containing many 2- to 3-inch pebbles. The terrace deposits overlie till and are overlain by 1-3 feet of brown noncalcareous silt and ½-1 foot of soil.

(3) Other smaller remnants of the terrace occur farther down the valley at gradually lower levels. At Wedron the surface of the terrace is about 560 feet and at Dayton it is 540 feet. At these places the terrace is largely an erosional level and is commonly underlain by bedrock or till although locally a little sand and gravel is present. A few small remnants of the terrace also occur along Indian Creek where they are also erosional and have only a thin cover of gravel.

*Correlation*

The Serena terrace is provisionally correlated with a terrace which is conspicuously developed farther up Fox Valley in the vicinity of Aurora and Elgin and has been correlated with West Chicago outwash.[46] In that area it occurs near the top of the bluffs and has a gradient down the valley approximately equivalent to that of the present river. Many remnants of the terrace occur along the valley between Aurora and the Marseilles quadrangle but in the absence of accurate maps for much of that area their exact correlation is difficult to confirm.

At the mouth of Fox Valley the Serena terrace appears to occur at nearly the same level as the Buffalo Rock terrace, although the terrace remnants are not close enough to determine their exact relationship, and it therefore appears that the West Chicago outwash is approximately equivalent to the lowest stage of the Kankakee Torrent.

[46]Leighton, M. M., Powers, W. E., and MacClintock, Paul, Geology and mineral resources of the Elgin, Geneva, and Barrington quadrangles: Illinois Geol. Survey, unpublished manuscript.

WEDRON TERRACE DEPOSITS

The Wedron terrace, named for the village of Wedron which is located on a remnant of the terrace, occurs along Fox Valley (pls. 1, 2; fig. 25) at a level varying from 10 to 40, usually about 20, feet below the Serena terrace. At the north side of the Marseilles quadrangle the surface of the terrace is at an elevation of approximately 550 feet and decreases to about 530 feet at Wedron. In the Marseilles quadrangle the terrace is commonly underlain by valley-train deposits of gravel and sand but near Wedron the terrace is in part an erosional level.

*Character*

(1) The largest remnant of the Wedron terrace occurs along the north side of Fox Valley south and southeast of Serena where its relations to the higher Serena terrace and the lower Sulphur Springs terrace are well shown. A bar-like ridge on the terrace near its west end has an elevation nearly as high as the Serena terrace and may be a remnant of it. Bedrock or till occurs at a shallow depth at the east end of the terrace but most of the terrace is underlain by fine gravel which thickens to the southwest and is at least 30 feet thick in a pit in the NE. ¼ SE. ¼ SE. ¼ sec. 35, T. 35 N., R. 4 E. (Serena Twp.), Marseilles quadrangle (fig. 98). The exposed gravel is well sorted and occurs in uniformly horizontal beds rarely more than a few inches thick and with little cross-bedding. Only about a fifth of the material is sand, and pebbles ¼-½ inch in diameter comprise nearly half of the gravel (app. D, table 6, W-3). The gravel is overlain by 1 to 3 feet of brown pebbly silt and soil. Boulders are common on the surface of the terrace.

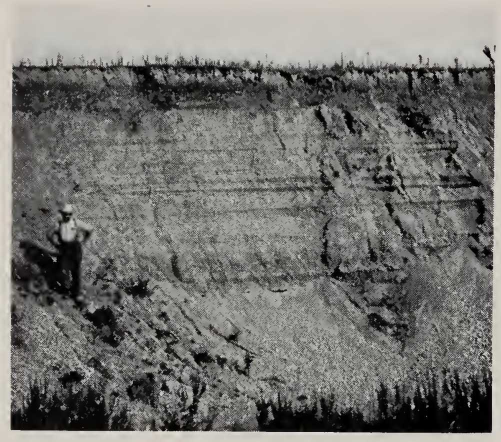

Fig. 98.—Outwash gravel in Wedron Terrace, south of Serena, NE. ¼ SE. ¼ SE. ¼ sec. 35, T. 35 N., R. 4 E. (Serena Twp.), Marseilles quadrangle.

(2) Most of the village of Wedron is situated on a terrace remnant whose surface is at an elevation of about 530 feet. West of an isolated hill which rises above the terrace on the north side of Wedron, the terrace is underlain by silt which is at least locally 15 feet thick. The terrace is in part an erosional level that in the pit in the NW. ¼ NE. ¼ NE. ¼ sec. 9, T. 34 N., R. 4 E. (Dayton Twp.), Ottawa quadrangle, truncates a typical ice-front gravel in that it contains many large cobbles and boulders, is poorly sorted, includes thin beds of clay, and is irregularly cross-bedded.

(3) South of Wedron the terrace is an erosional level and although its remnants commonly have a few inches of sand or gravel overlying bedrock, in some places the bedrock directly underlies the soil.

*Correlation*

The Wedron terrace is provisionally correlated with the well-developed low terrace in the Elgin-Aurora area which has been correlated with the Fox Lake interval of Valparaiso time.[47] It occurs at about the same distance below the Serena terrace as the Fox Lake lies below the West Chicago, and is the lowest level underlain by definite valley-train deposits.

The Wedron terrace is not definitely recognized in the lower few miles of Fox Valley, but a projection of its surface is only slightly above the Ottawa terrace which in turn is correlated with Lake Chicago Outlet River.

POST-VALPARAISO DEPOSITS

As the Valparaiso glacier receded, its melt-water accumulated between the moraine and the retreating ice-front in the Lake Michigan basin to form glacial Lake Chicago. At various times water from the lake escaped through DesPlaines and Illinois valleys in what has been called Outlet River (fig. 90). It widened and deepened and probably deposited sand and gravel in Illinois Valley in the Marseilles and Ottawa quadrangles. However, Lake Chicago and Outlet River continued into the Mankato substage, and whatever deposits Outlet River laid in these quadrangles during the Cary substage were either subsequently eroded or are indistinguishable from those which it laid during the Mankato substage, and so all of its deposits are considered as of the latter age.

## Mankato Substage[48]

Deposits of Mankato age in the Marseilles-Ottawa-Streator area occur in (1) the Cryder Lake beach and Ottawa terrace in Illinois Valley, developed by the waters of Outlet River of Lake Chicago, and (2) Sulphur Springs terrace in Fox Valley, Indian Creek terrace along Indian Creek and Fox Valley, and similar but lesser and unnamed terraces along other tributary valleys, developed in accord with successive levels of Outlet River in Illinois Valley.

### CHARACTER

#### CRYDER LAKE BEACH[49]

The Cryder Lake beach consists of a steep slope 20 to 25 feet high which extends for nearly a mile along the east side

[47]Powers, W. E., and Ekblaw, George E., Glaciation of the Grays Lake quadrangle: Geol. Soc. America Bull. vol. 51, pp. 1329-1336, 1940; Illinois Geol. Survey Cir. 63, 1940.

[48]Named for Mankato, Minn. The substage was formerly called "Late Wisconsin."
Leighton, M. M., The naming of the subdivisions of the Wisconsin glacial age: Science, n.s., vol. 77, no. 1989, p. 168, Feb. 1933.

[49]Named for Cryder School which is situated on the top of the beach north of Morris.
Culver, H. E., Geology and mineral resources of the Morris quadrangle: Illinois Geol. Survey Bull. 43, pp. 180-183, 1923.

of the Marseilles quadrangle north of Illinois Valley and east of O'Brien Run (pl. 1 and fig. 108). The top of the slope is at an elevation of 545 to 550 feet. Except for minor breaks, the beach continues eastward for about 12 miles in the Morris quadrangle and is also present along the south side of Illinois Valley in the Morris area.[50]

The beach is generally underlain by till but in the Morris area a little gravel is locally present along the slope and in a low ridge 1 to 3 feet high at the top of the slope. Boulders are common on the surface, especially near the base of the steep slope.

#### OTTAWA TERRACE

The Ottawa terrace, named for the city of Ottawa, most of which is situated on the terrace, occupies the greater part of the floor of Illinois Valley in both the Marseilles and Ottawa quadrangles (pls. 1, 2, and fig. 108). The terrace has extensive flat areas but at many places is traversed by channels of varying width and depth. The surface of the terrace is largely 20 to 40 feet above the natural low-water level of Illinois River except in the channels, the bases of which are locally only a few feet above the floodplain. Near Buffalo Rock and westward the terrace is somewhat lower.

The terrace is generally underlain by bedrock at a depth of less than 3 feet, but deposits of gravel and sand are locally present and bars of gravel occur at many places in the channels cutting the terrace. East of Marseilles the terrace is underlain by the Vermilionville sandstone, and the surface material is a brown sandy residual soil formed by weathering of the sandstone.[51] A similar soil overlies St. Peter sandstone in the terrace at Ottawa. Recent deposits of pebbly silt, peat, and muck are common on the terrace near the bluffs, especially in the channels, many of which are filled by streams from the smaller tributary valleys and by Illinois River itself during unusually high floods.

Fig. 99.—Coarse flattish cobbly gravel deposited by Outlet River in the Ottawa Terrace, in pit of the Moline Consumers Company, SW. ¼ SW. ¼ SW. ¼ sec. 18, T. 33 N., R. 3 E. (Ottawa Twp.), Ottawa quadrangle.

East of Ottawa the gravel deposits occur mainly in the channels in the terrace and consist principally of well-rounded, well-sorted dolomite and limestone pebbles many of which are more than 2 inches in diameter. Where the deposits are thicker they usually form roughly oval ridges oriented with the trend of the valley and rising as much as 10 feet above the general level of the terrace.

The largest area of gravel occurs west and north of Buffalo Rock and is exposed in pits of the Moline Consumers Company, in secs. 13, 24, T. 33 N., R. 2 E. (Utica Twp.), and sec. 18, T. 33 N., R. 3 E. (Ottawa Twp.), Ottawa quadrangle. The deposit has a maximum thickness of about 40 feet near Buffalo Rock but thins to the west and is only 8 to 15 feet thick about half a mile west. Only the upper 5 to 10 feet of the gravel occurs above water-level. The gravel is very coarse, containing many cobbles (fig. 99) and only about 20 per cent sand. The material is mostly dolomite and limestone but pebbles of igneous and metamorphic rocks are not rare. The gravel is

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[50] Culver, H. E., op. cit.

[51] Smith, R. S., DeTurk, E. E., Bauer, F. C., and Smith, L. H., Grundy County soils: Univ. of Illinois Agr. Exp. Sta. Soil Report 26, pp. 34, 35, 1924.

Hopkins, Cyril G., Mosier, J. G., Pettit, J. H., and Readhimer, J. E., LaSalle County soils: Univ. of Illinois Agr. Exp. Sta. Soil Report 5, p. 33, 1913.

overlain by about 2 feet of brown soil and noncalcareous silt.

A deposit of similar coarse cobbly gravel at least locally underlies the terrace east of Buffalo Rock where about 5 feet of gravel was exposed in digging a ditch in the NW. ¼ SE. ¼ NW. ¼ sec. 16, T. 33 N., R. 3 E. (Ottawa Twp.), Ottawa quadrangle. The gravel is overlain by 3 to 4 feet of peat and muck.

The gravel underlying the bar-like ridge southeast of Buffalo Rock in the north part of sec. 20, T. 33 N., R. 3 E. (South Ottawa Twp.), Ottawa quadrangle, partly submerged by the lake formed by the Starved Rock dam, is reported to be very coarse. Gravel also underlies part of the terrace east of Fishburn School in the E. ½ sec. 20, but most of the thicker part of the deposit has been worked out. The east part of the deposit, near the outcrop of the St. Peter sandstone, is reported to have been coarse. The gravel becomes finer and thinner to the west and in a pit in the NW. ¼ NE. ¼ SE. ¼ sec. 20, it is a fine gravel containing lenses of sand (app. D, table 6, W-14).

Gravel underlies part of a large remnant of the terrace northeast of Ottawa at the mouth of Fox Valley in sec. 31, T. 34 N., R. 4 E. (Dayton Twp.), sec. 6, T. 33 N., R. 4 E., and sec. 1, T. 33 N., R. 3 E. (Ottawa Twp.), Ottawa quadrangle. The gravel is irregular in distribution and variable in thickness. Although absent in part of the terrace it is reported to be 18 feet thick in a well at the house near the center of sec. 6. The gravel is poorly exposed but appears to be coarse, well rounded, and composed largely of dolomite and limestone.

Similar coarse gravel locally underlies a terrace on the south side of Illinois Valley at Ottawa. It is exposed in a small pit in the SE. ¼ SE. ¼ SW. ¼ sec. 11, T. 33 N., R. 3 E. (South Ottawa Twp.), Ottawa quadrangle.

A large area of the terrace south of Seneca in the vicinity of Farley School is underlain by sand and gravel. However, these deposits are similar in character to those exposed along many of the nearby ravines where they are overlain by till and are thought to be Shelbyville in age (p. 156).

#### SULPHUR SPRINGS TERRACE

The Sulphur Springs terrace, named for the Sulphur Springs health resort which is situated on a remnant of the terrace, occurs along Fox Valley in both the Ottawa and Marseilles quadrangles (pls. 1, 2; figs. 24, 25). The surface of the terrace is about 20 feet above the natural low-water level of the river below Dayton and also in the Marseilles quadrangle, but decreases from Wedron to Dayton because the water-level is raised by the dam at Dayton, and it is submerged for some distance north of the dam.

At Sulphur Springs bedrock occurs at a shallow depth, but a short distance north a thin deposit of gravel containing many well-rounded pebbles of limestone is present. At Wedron the terrace is underlain by a few feet of horizontally bedded fine sandy gravel (app. D, table 6, W-4) which contains coarse sand beds and overlies bedrock, as exposed in a pit in the NE. ¼ NW. ¼ SE. ¼ sec. 9, T. 34 N., R. 4 E. (Dayton Twp.), Ottawa quadrangle. The gravel consists mostly of well-rounded ½- to 1-inch pebbles in a matrix of sand. At Dayton the upper 6 feet of the terrace is brown medium-grained sand with a few streaks of pebbles overlying bedrock, and northeast of Wedron in the NE. ¼ NE. ¼ NW. ¼ sec. 2, T. 34 N., R. 4 E. (Rutland Twp.), Marseilles quadrangle, the upper 3 feet of the terrace is brown sand.

#### INDIAN CREEK TERRACE

The Indian Creek terrace, named for a tributary to Fox River north of Wedron, occupies most of the valley-floor of Indian Creek at a level 10 to 15 feet above the low-water level of the creek. The terrace has a limited distribution along Fox Valley where it is generally inseparable from the Recent floodplain. Some parts of the terrace are subject to flood at times of unusually high water and are mantled with a thin layer of recent alluvium, mostly sandy silt.

At most places along Indian Creek the terrace is underlain by a succession of a few inches of dark brown sandy soil, 1-2 feet of brown sandy silt or silty sand, and 1-3 feet of light brown medium-grained sand overlying bedrock or till. Along Fox

Valley at the mouth of Indian Creek the terrace is represented by a narrow terrace remnant about 10 feet below the Sulphur Springs terrace and about 5 feet above the floodplain of Fox River (fig. 25).

#### TERRACES IN VERMILION VALLEY

Four terrace levels, differing in elevation by 10 to 15 feet, occur along the west side of Vermilion Valley near Streator and Kangley in the SE. ¼ sec. 22 and the NW. ¼ sec. 35, T. 31 N., R. 3 E. (Eagle Twp.), Streator quadrangle (pl. 3). The lowest terrace occurs only a few feet above the floodplain and the highest is a few feet below the top of the bluffs. Elsewhere along the valley fewer terraces are present and the intervals between them are irregular. The terraces are mostly erosional levels underlain by bedrock or till but many of them have a thin cover of gravel and sand.

#### TERRACES IN OTHER VALLEYS TRIBUTARY TO ILLINOIS VALLEY

Terraces 5 to 15 feet above the present alluvial flats occur along many of the streams tributary to Illinois Valley. The terraces are underlain mostly by bedrock or till, although at some places a few inches to 4 or 5 feet of poorly sorted sandy and pebbly silt or silty gravel occurs above the bedrock or till.

Two terraces, both underlain by bedrock with a thin cover of angular, cobbly gravel, mostly derived from the local bedrock, are present along Covel Creek. The terraces are about 30 and 20 feet above the stream in the lower part of the valley but the stream and terraces converge upstream.

#### TERRACES IN OTHER VALLEYS TRIBUTARY TO FOX VALLEY

Terraces are common along many of the other valleys tributary to Fox Valley, especially the larger streams such as Mission and Brumbach Creeks in the Marseilles quadrangle and Crooked Leg and Buck Creeks in the Ottawa quadrangle. These terraces are mostly erosional levels and are underlain by till or bedrock at a shallow depth, but many have a thin cover of sand or poorly sorted gravel composed mostly of material derived from the till. At least three terraces are recognizable along some of the valleys, as in the valley along the east side of Fox Valley one mile south of Sulphur Springs (fig. 27).

#### CORRELATION

The Cryder Lake beach is believed to mark the highest level in the Morris basin of the waters of Outlet River from Lake Chicago, principally because it is the only well-developed and well-preserved shoreline in the basin and in those respects is comparable to the Lake Chicago beaches. A few indistinct shorelines at higher levels in the basin are thought to have been formed by the Kankakee Torrent whose levels were much less persistent than those of Lake Chicago.

The deposits of Outlet River in the Marseilles and Ottawa quadrangles are correlated with the Toleston or lowest stage of Lake Chicago, which is the last time the river carried any large volume of waters, because the width of the Toleston outlet channels at Chicago indicates that the volume of the water was sufficient to cover the entire area occupied by the earlier stages of the river. The Toleston beach is considered to be Mankato in age because it extends along the shore of Lake Michigan north of the terminal moraine of the Mankato ice near Milwaukee, Wisconsin, and Ludington, Michigan[52], and therefore the Outlet River deposits in the Marseilles and Ottawa quadrangles are also considered of Mankato age.

Outlet River appears to have eroded the floor of Illinois Valley to a depth of approximately 40 feet, but the various levels to which the valley was cut by the stages of Lake Chicago are not preserved in Illinois Valley. Although the presence of two or more low-level terraces along some of the tributary valleys indicates erosion to temporary base-levels formed by the water-levels in the main valley, specific correlations with the levels of Lake Chicago have not been possible. In some valleys, especially Vermilion Valley, the relative position and perhaps even the number of terraces may also have been

[52]Leverett, Frank, in The Pleistocene of Indiana and Michigan: U. S. Geol. Survey Monograph, vol. 53, p. 350, 1915.

influenced by the presence of bedrock strata of varying resistance to erosion in the lower courses of the valleys.

## Undifferentiated Wisconsin

### soil

The soil which mantles most of the Marseilles-Ottawa-Streator area is derived from materials, especially the widespread loess, which accumulated at various times in the Wisconsin age. Because the soil is fairly uniform in character regardless of the ages of the materials, it is discussed as a unit.

Soil covers all the area except where the bedrock or glacial deposits have been exposed by the recent erosion of streams and wind, by landslides, or by artificial agencies. The soil has developed by weathering of unconsolidated materials and bedrock whose original character is almost completely altered in the upper part of most soils but becomes increasingly recognizable toward the base as the soils grade through partially weathered material to the unaltered parent material.

#### *Thickness*

The thickness of the soil varies greatly throughout the Marseilles-Ottawa-Streator area. It is only a few inches thick at some places but is locally as much as 13 feet thick. The average thickness is probably between 3 and 4 feet. Many factors, the most important of which are physical character and chemical composition of the parent materials, types of vegetation, drainage, degradation and aggradation, gradient of slopes, length of time, and climate, influence the thickness of the soils. The major variations of thickness are closely related to the physical character of the parent material, especially porosity and consequent underdrainage. Soils developed on porous materials like loess are relatively thicker than those developed on clayey tills; soils developed on thick loess over till are thicker than soils developed on thin loess over till; and soils developed on loess overlying sand are thicker than on loess overlying till. Relatively sharp local variations in thickness are produced by gradation. Degradation by wind and sheet-wash may remove some of the soil, thus making it thinner, and the material so eroded may be deposited on the soil elsewhere, thus making it thicker by aggradation. The differences in length of time of soil formation in the area are insufficient to produce recognizable differences in thickness. The climate is essentially uniform for the area and the other factors influencing thickness produce no appreciable differences in this area.

With few exceptions the soils are developed on materials which were originally calcareous, and in the weathering process the carbonates are among the first minerals to be dissolved and removed in solution. For that reason the thickness of the noncalcareous zone is, in this area, a rough measure of the thickness of the soil, although usually there are a few inches of partially leached and slightly oxidized material below the noncalcareous zone. The thickness of the noncalcareous zone was determined by auger-borings (table 6), most of which were made in comparatively flat locations where the effects of gradation were probably not important, or were at least typical of the area.

#### *Character*

Where the weathering processes have been active long enough to produce a mature soil it may be differentiated into distinct horizons or zones which together form the soil profile, but in the Marseilles-Ottawa-Streator area the soils are comparatively immature and the profile is not well developed.

The soil profile is commonly differentiated into the following horizons:

*"A" Horizon.*—The A horizon is the eluvial zone, in which not only a large part of the original constituents of the parent rock has been chemically decomposed but much of the original material has been leached and mechanically removed by percolating waters. At the top is a humus layer consisting of a concentration of organic matter in all stages of decay mixed with a variable quantity of clay and silt. Below the humus the A horizon is a pulverulent mixture of clay and silt.

*"B" Horizon.*—The B horizon is the illuvial zone, in which chemical decomposition has also been active and in which some of the material removed from the

Table 6.—Thickness of the Noncalcareous Zone in Auger Borings

| Topographic position | Quad-rangle | Parent material | Described in geologic sections[a] | Number of borings | Thickness | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Ave. | | Max. | | Min. | |
| | | | | | Ft. | In. | Ft. | In. | Ft. | In. |
| Cropsey moraine | Streator | Silt or silt on till | 99 | 5 | 3 | | 3 | 6 | 2 | 6 |
| Frontal slope of Farm Ridge moraine | Ottawa | Silt on gravel | 53 | 1 | 13 | 6 | .. | .. | | .. |
| Farm Ridge moraine | Ottawa | Thin silt on till | 55, 56, 59, 76 | 7 | 4 | | 6 | 6 | 1 | 3 |
| Subglacial channels in Farm Ridge moraine | Ottawa | Silt on sand | 52, 54, 58 | 3 | .. | .. | 11 | 9 | 5 | 6 |
| Farm Ridge ground-moraine | Ottawa | Thin silt on till | 51 | 1 | 3 | 2 | .. | .. | .. | .. |
| Marseilles moraine | Marseilles | Silt on sand | 35 | 1 | 5 | 2 | .. | .. | .. | .. |
| Marseilles moraine | Marseilles | Thin silt on till | 37, 40 | 15 | 3 | 1 | 4 | 4 | 2 | 3 |
| Lake Wauponsee | Marseilles | Silt on till | 41, 45, 46 | 9 | 3 | 6 | 4 | 3 | 3 | .. |
| Lake Ottawa north of Illinois Valley | Ottawa | Silt on till | 50, 60-64, 67 | 15 | 4 | 6 | 6 | .. | 3 | 6 |
| Lake Ottawa south of Illinois Valley | Ottawa | Silt on sand or gravel | 71, 73, 74 | 16 | 3 | 10 | 9 | .. | 2 | 6 |
| Lake Pontiac | Streator | Silt on sand | 80, 82, 91, 97, 98 | 13 | 3 | 4 | 5 | 3 | 2 | 6 |
| Lake Pontiac | Streator | Silt or silt on till | 87, 89, 95, 100 | 11 | 2 | 10 | 4 | .. | 2 | .. |

[a]The geologic sections are given in appendix A.

A horizon is redeposited, including many organic and inorganic colloids, clay minerals, gypsum, and calcium carbonate. It is comparatively compact and hard when dry and sticky when wet and is sometimes called "hardpan."

*"C" Horizon.*—The parent material is commonly called the C horizon although it is not part of the soil.

Where the soil profile is mature, these horizons can be further subdivided[53] on the basis of variations in texture and mineral and organic content.

A large number of soil types have been differentiated in these quadrangles on the basis of variations in the soil profile, and they have been classified into five groups[54] as follows:

*Upland prairie.*—The upland prairie soils have developed in the unforested areas which were covered by dense growths of wild prairie grasses. These soils contain a relatively large amount of organic matter and are dark in color. The predominate type is brown silt loam. Black clay loam is also widely distributed in the poorly drained areas—the closed depressions of the moraines, the small upland valleys with low gradients, and the flats of glacial lake beds. Much of it was formerly swampy, which accounts for the very high content of organic matter. Clay washed from the surrounding higher areas gives the soil its clayey texture.

*Upland timber.*—The upland timber soils occur adjacent to the streams where the growth of forests continued for a long time. They contain much less organic matter than the prairie soils and are lighter in color. The predominant types are yellow silt loam and yellow-gray silt loam. The yellow silt loam occurs on the well-drained slopes of the valley-walls while the yellow-gray silt loam occurs in the flatter areas bordering the prairies.

*Terrace.*—Soils developed on the terraces overlie a wide variety of materials and consequently are generally more variable than the upland soils. Although brown silt loam is the predominant type, large areas of brown sandy loam and black clay loam occur on the Illinois Valley terraces.

*Swamp and bottomland.*—These soils are developed on overflow lands along

[53]Leighton, M. M., and MacClintock, Paul, Weathered zones on the drift-sheets of Illinois: Jour. Geology, vol. 38, No. 1, pp. 28-53, 1930; Illinois Geol. Survey Rept. Inv. 20, 1930.

[54]Hopkins, C. G., Mosier, J. G., Pettit, J. H., and Readhimer, J. E., LaSalle County soils: Univ. Illinois Agr. Exp. Sta. Soil Report No. 5, 1913.

Mosier, J. G., Holt, S. V., Fisher, F. A., DeTurk, E. E., and Snider, H. J., Livingston County soils: Univ. Illinois Agr. Exp. Sta. Soil Report No. 25, 1923.

Smith, R. S., DeTurk, E. E., Bauer, F. C., and Smith, F. H., Grundy County soils: Univ. Illinois Agr. Exp. Sta. Soil Report No. 26, 1924.

Fig. 100.—Lenticular deposits of poorly sorted gravel, sand, and silt in the floodplain of stream south of Seneca, NE. ¼ NE. ¼ NE. ¼ sec. 35, T. 33 N., R. 5 E. (Brookfield Twp.), Marseilles quadrangle.

streams, in swamps, and in poorly drained lowlands. Along Illinois Valley the predominant type is the deep brown silt loam that underlies the floodplain of the river. Peat underlies some of the swampy areas on the terraces. Highly variable mixed loam underlies the floodplains of the smaller streams.

*Residual.*—These soils were produced by weathering of bedrock. They consist largely of brown sandy loam and occur mainly on Illinois Valley terraces east of Marseilles where the Vermilionville sandstone occurs near the surface in large areas.

### *Correlation*

The materials from which the soils developed are largely Wisconsin in age, although the humus has in part accumulated during the Recent age and some wind-blown mineral matter has no doubt been added by Recent dust storms. Formation of the soil started as soon as the parent materials were exposed to weathering, which varies from the time the Cropsey drift was first uncovered by retreat of the Cropsey glacier during Tazewell time to the last stage of the Lake Chicago Outlet River in Mankato time.

## RECENT STAGE

Since the last Lake Chicago waters passed through Illinois Valley a wide variety of materials have accumulated in many different types of deposits in both upland and valley areas as a result of activities of wind and of water in streams, rivers, lakes, springs, swamps, and underground. Most of these deposits are still in process of formation. Some are transitory as alternate erosion and deposition moves them progressively to lower levels.

### CHARACTER

#### FLOODPLAINS

Alluvial deposits of silt, clay, sand, and gravel underlie the floodplains of the rivers and streams as is shown on plates 1-3 and even much farther up many of the valleys where they are too narrow to map.

Built largely by the variable currents of rivers in flood these deposits consequently are highly variable in composition (fig. 100). The floodplain of Illinois River is generally underlain by dark gray sandy silt containing a large amount of organic material, but lenses of sand and gravel (usually silty) are common, and fragments of shells, wood, and other extraneous materials are abundant locally. Materials underlying the floodplains of the tributary valleys are similar in character although in general they contain a larger proportion of coarse materials. The composition of the alluvium depends on the character and relative abundance of the bedrock and glacial materials in each drainage system.

#### CHANNEL DEPOSITS

Deposits of gravel and sand are common along the channels of nearly all the rivers and streams. Much of this material is in process of migration down the valleys, and it shifts in position with varying currents. At times of low water many deposits are stranded above water-level (fig. 101). The materials are variable, especially along the smaller valleys where the source bedrock and glacial deposits vary greatly. Coarse, bouldery gravel and sand was dredged from Illinois River when it was deepened for the Illinois

Waterway, as shown by the waste-piles along the north side of the river east of Marseilles in secs. 20 and 21, T. 33 N., R. 5 E. (Manlius Twp.), Marseilles quadrangle.

### ALLUVIAL FANS

Many of the streams have built fans of alluvium where they emerge from narrow valleys to the broad flats of larger valleys. In some fans the alluvial material is as much as 30 feet thick, but usually it is thinner. The material is highly variable but is usually a sandy and clayey silt with pebbles and lenses of gravel and sand. It is similar to the material underlying the floodplains of the valley that contributed the material in the fan.

### SLOPE-WASH

The lower parts of nearly all slopes are mantled with a thin deposit of clayey silt, sandy silt, or sand washed down from higher parts of the slopes. Slope-wash deposits of considerable extent are present at the base of many of the high valley-walls. They grade into the alluvial fans at the mouths of ravines.

### LANDSLIDES AND SLUMP

Large masses of materials which have slumped or fallen from the higher slopes also are common along nearly all the valleys where streams have undercut the banks and along slopes where ground-water loosens the material and facilitates slippage. Many landslides occur below the high banks of glacial deposits along Indian Creek in the Ottawa quadrangle and the lower parts of Brumbach Creek, Walbridge Creek, and Long Point Creek in the Marseilles quadrangle.

### SWAMP DEPOSITS

Many swamps were formerly present in both upland and valley areas, but most of them have been drained. In some of the swamps the deposits consist of peat, in others it is largely black clay or silt containing much organic matter. The distribution of the deposits of peat more than 30 inches thick has been determined by the Soil Survey[55] by numerous auger-borings to that depth. The larger deposits

FIG. 101.—Recent deposits of gravel and sand along channel of stream south of Seneca, NE. ¼ NE. ¼ NE. ¼ sec. 35, T. 33 N., R. 5 E. (Brookfield Twp.), Marseilles quadrangle.

occur on the terraces in Illinois Valley, most of them in areas that are at present swamps. Southwest of Seneca peat is reported to underlie an area about 1¼ miles long and up to a quarter of a mile wide, near the base of the bluffs in secs. 27, 28, 33, and 34, T. 33 N., R. 5 E. (Brookfield Twp.), Marseilles quadrangle. A smaller area is also reported a short distance north of this, in the SE. ¼ NE. ¼ sec. 28 and SW. ¼ NW. ¼ sec. 27. Peat is also reported to underlie a low area west of Ottawa about a mile long and variable in width in secs. 9 and 16, T. 33 N., R. 3 E. (Ottawa Twp.), Ottawa quadrangle. The largest mapped areas of peat are west of Buffalo Rock in secs. 13, 14, 15, T. 33 N., R. 2 E. (Utica Twp.), Ottawa quadrangle, but these areas, formerly large swamps, are now mostly flooded by the lake behind Starved Rock dam of the Illinois Waterway.

### SPRING DEPOSITS

Small deposits of tufa, travertine, and limonite are present at the orifices of many of the springs which issue at the contact between bedrock and drift and at the base of beds of gravel or sand in the drift. The deposits consist mostly of brownish-gray porous calcium carbonate which commonly contains leaves or impressions of leaves and other plants.

[55]Univ. of Illinois Agr. Exp. Sta. Soil Reports 5, 25, 26.

Rusty-brown limonite is locally present, especially where the springs contain drainage from coal mines.

### GROUNDWATER DEPOSITS

Groundwater has deposited a variety of minerals in both bedrock and surficial deposits. Many minerals dissolved near the surface are deposited a short distance below and bear a close relation to the surface. This is well shown in the zone of concentration of the soil profile (p. 176), where colloids, clay minerals, calcite, and limonite that are dissolved from the higher zones are redeposited. Other minerals have been transported in solution from greater distances and have a more widespread distribution through the rocks. Some glacial sands and gravels are cemented by calcite or limonite, and bedrock sandstones have calcitic and limonitic zones of secondary origin. Crystals of pyrite and gypsum are common in many different kinds of rocks and frequently they are concentrated along the bedding-planes and are more abundant in the weathered than in the fresh material. Many of the originally rough-surfaced quartz grains of the sandstones now have smooth crystal faces produced by the deposition of secondary quartz by groundwater. In the St. Peter sandstone the sand grains near the outcrops or along joints are commonly enlarged while the fresher sand is composed of well-rounded grains. The sand grains of the Pennsylvanian sandstones are nearly all partly enlarged by silica but as the amount of the secondary enlargement shows no relation to the present ground surface it is questionable how much, if any, is of Recent origin.

### SAND DUNES

Recent deposits of sand in dunes occur locally on terraces in Fox and Illinois valleys. Several dunes occur northeast of Serena, on a terrace in Fox Valley in sec. 20, T. 35 N., R. 5 E. (Mission Twp.), Marseilles quadrangle. The dunes are covered with vegetation and are not active. The sand is fine-grained, well-sorted, and light yellowish-brown. In the highest dunes the sand is probably 15 feet thick but larger dunes occur a short distance north, beyond the boundary of the Marseilles quadrangle. The sand is derived largely from the terrace on which the dunes occur.

Low mounds of sand, probably windblown, formerly occurred on Buffalo Rock in the SE. ¼ sec. 18, T. 33 N., R. 3 E. (Ottawa Twp.), Ottawa quadrangle, but have mostly been removed in stripping coal. The sand is largely fine-grained and silty but contains many medium-sized grains of well-rounded St. Peter sand. The highest dune was about 10 feet high.

Several low hills of St. Peter sandstone near the mouth of Covel Creek in the NW. ¼ SW. ¼ sec. 21, T. 33 N., R. 3 E. (South Ottawa Twp.), Ottawa quadrangle, have been confused with dunes. The bedrock is covered with a few inches of loose sand mostly derived by weathering of the sandstone.

### CORRELATION

The Recent age is generally considered to begin with the recession of the last Wisconsin glaciers about 25,000 years ago.[56] However, the transition from the Wisconsin age to the Recent was a gradual one. The processes active in the later part of the Wisconsin continued without interruption into the Recent and no changes in the character of the deposits are distinguishable. Consequently the deposits included in the Recent stage vary widely in age. Some have accumulated entirely or in part in historical times; deposition of others no doubt commenced in Wisconsin times and extended for variable lengths of time, and many are still in active process of formation. On the Ottawa terrace in Illinois Valley the deposits included in the Recent can be no older than Mankato time. On the Lake Ottawa flat the deposits may be as old as Cary time, and on the moraines some of the deposits may be as old as Tazewell time.

[56] Kay, G. F., and Leighton, M.M., Eldoran epoch of the Pleistocene period: Geol. Soc. Am. Bull., vol. 44, p. 672, 1933.

# CHAPTER VI—STRUCTURAL GEOLOGY

BY

J. NORMAN PAYNE

## GENERAL PRINCIPLES

Briefly, structural geology treats of the attitude of rock strata in place. As most of the bedrock strata were essentially horizontal when deposited, any existing departure from horizontality indicates that they were affected by some major earth movement after their deposition.

The structure of a rock stratum is determined by its *dip* or divergence from a horizontal plane, measured as so many degrees or as so many feet per mile in the direction of maximum divergence, and by its *strike*, the direction of the intersection of its surface with a horizontal plane, which is always at right angles to the direction of the dip.

The principal rock structures are *folds* and *faults*. Upward folds much longer than wide are called *anticlines* or *arches;* downfolds much longer than wide are called *synclines*; similar upfolds and downfolds relatively equidimensional are called respectively *domes* and *basins*. Beds dipping uniformly in one direction for a long distance form a *monocline*. Folds that have about the same dip on each side or *limb* are *symmetrical* and those of which one limb dips more steeply than the other are *asymmetrical*. The line along which folding apparently occurs is termed an *axis*. Slope along the axis is termed *plunge* or *pitch*. Appreciable movement of rock strata on one side of a joint or fracture with reference to those on the other side creates a *fault*. The *fault-plane* may be either *vertical* or *inclined*. If the beds on the upper side of an inclined fault-plane appear to have slipped down, presumably as a result of local stretching or lengthening of the earth's crust, the fault is a *normal* or *gravity* fault, but if they appear to have slipped or been pushed up over those on the under side, the fault is called a *thrust* fault and implies a local shortening of the earth's crust.

Structures may be depicted by cross-sections, which show clearly the attitude of the rocks along a chosen line (pls. 28, 29) but do not show areal variations, or by structure contour-maps which are similar to topographic maps, except that the contours represent lines of equal elevation on the top of certain beds or formations instead of on the ground, and which therefore provide a complete areal representation of the structure of such beds or formations. The relative accuracy and detail of structure contour-maps is a function of the number and reliability of available datum points.

In regions where outcrops are abundant, the rock structures may be determined with considerable accuracy by actual measurements of the dip of the rocks at numerous points or by an accurate survey of the location and elevation of outcrops of key beds. But in most of Illinois, as in many other regions, outcrops are so few that records of wells and other borings provide most of the available structural data. The elevation of any key-bed reported in such records is easily ascertained by subtracting the depth to it from the surface elevation. As the number of borings to any formation naturally decreases with the depth at which it lies, structure maps of higher formations are more detailed and those of lower horizons are more generalized.

Because structure contour-maps are areal representations of recognizable bedrock surfaces, the approximate depth to such surfaces at any point on the maps is the difference between the elevations of the surface and of the ground at that point. The approximate depth to other

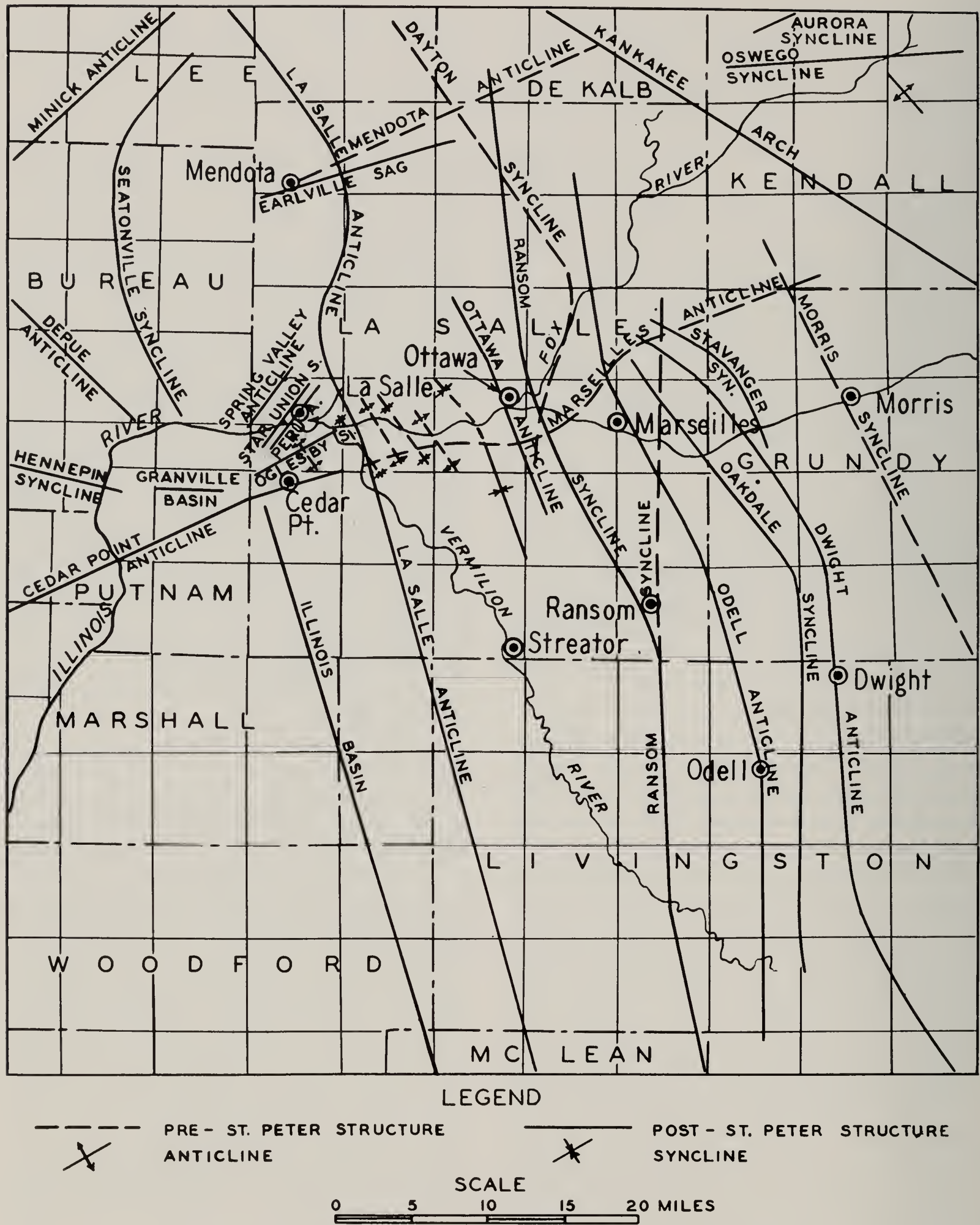


FIG. 102.—Map of north-central Illinois showing axes of folds.

surfaces or beds, especially those of commercial value or of important resources, such as coals, clays, water-bearing and mineral-bearing formations, and potential oil- or gas-producing strata, for which structure maps may not be prepared but whose position with reference to surfaces structurally mapped is known, may be also ascertained. The thickness of strata between any two surfaces that are structurally mapped is the difference of elevations of the surfaces. From a series of structure contour-maps drawn on several successive formations, the time, character, and magnitude of various structural deformations, the direction and magnitude of the forces producing them, and the amount of erosion between different periods of deposition may be inferred.

Structure contour maps are especially valuable in areas where factors favorable for oil production exist, because they show the location and size of anticlinal areas, which constitute one of the most favorable sites for the accumulation of oil.

In the Marseilles, Ottawa, and Streator quadrangles most of the strata appear to lie horizontal, although at a few places they are tilted, but actually the apparently horizontal beds are inclined at low angles. For example, the beds in Starved Rock State Park appear to be perfectly horizontal, but along the south side of Illinois Valley the top of the St. Peter sandstone may be observed to descend gradually from near the top of the bluffs in the park eastward to the base of the valley-walls near Covel Creek.

As earth movements in the area occurred at more than one time during its geologic history, the various formations are not always parallel to each other. As each successive movement affected all the earlier formations, successively deeper formations are affected by more movements, as is shown by the series of formation-surface contour maps covering the region (pls. 15, 19, 22, 24, 26).

The data used in making the maps were derived almost entirely from records of borings of which the surface elevations were obtained by estimation from topographic maps, by transit and level, or by short hand-level traverses, so that the maximum possible error in elevation is 20 feet. Two major anticlinal structures—the LaSalle anticline and the Kankakee arch, several lesser anticlinal structures, and complementary major and lesser synclinal structures in the region (fig. 102) are revealed by the maps. Some of the structures were formed prior to the deposition of the St. Peter sandstone, so that they appear only in the older formations (pls. 15, 19; fig. 102); some of these suffered later movement, so that the degree of folding is different in the older and in the younger formations; and other structures did not originate until after St. Peter time, so that they are of about equal magnitude in all formations. In some cases the axes of the structures are not exactly superposed in successive formations.

## STRUCTURAL FEATURES

*LaSalle anticline.*[1]—The most prominent structural feature of north-central Illinois is the LaSalle anticline, a broad step-fold or monocline having a maximum westward dip of approximately 2000 feet per mile and an eastward dip of less than 25 to 50 feet per mile on the higher formations. The dip of the formations below the Pennsylvanian is much greater than that of the Pennsylvanian strata, especially on the west limb (pls. 28, 29). The differential elevation measured between the deepest part of the Granville basin and the crest of the LaSalle anticline east of Oglesby is about 1700-1800 feet on the top of the St. Peter and the top of the Galesville formations (pls. 15, 22).

The axis of the LaSalle anticline in north-central Illinois area trends approximately S. 40° E. from eastern Lee County to about six miles north of Mendota, whence it swings in a broad arc south and southwest to a point about six miles north of LaSalle, thence continues S. 24° E. to about a mile east of Oglesby, where it abruptly changes to about S. 15° E., and continues in this direction to northern McLean County. From the north almost to LaSalle the crest of the anticline is relatively even, with a few low peaks and shallow sags, but from a little north of LaSalle the anticline plunges steadily southward.

The anticline constitutes the eastern boundary of the great regional structural depression known as the Illinois basin, whose principal axis roughly parallels that of the anticline. Disregarding the minor flexures in it, the portion of the basin in north-central Illinois pitches gently to the southeast.

*Kankakee arch.*[2]—The northeastern part of north-central Illinois is crossed by the

[1]Cady, G. H., Structure of the LaSalle anticline: Illinois Geol. Survey Bull. 36, pp. 85-188, 1920.

[2]Ekblaw, George E., Kankakee arch in Illinois: Geol. Soc. America Bull., vol. 49, pp. 1425-1430, 1938; Illinois Geol. Survey Circular 30, 1938.

Kankakee arch, an asymmetrical anticline whose steeper limb is to the southwest and dips more than 100 feet per mile. The maximum differential elevation of the structure is probably between 1300 and 1500 feet (pl. 15, fig. 102).

The anticline trends about S. 40° E. through southeastern DeKalb, northeastern LaSalle, and southwestern Kendall counties and plunges to the southeast. It is traversed by at least one longitudinal fault of which the downthrow side is on the northeast.

*Dwight anticline.*—An apparently symmetrical anticline 25 to 30 miles east of and roughly parallel to the LaSalle anticline is herein named Dwight after the town of Dwight, Livingston County, which is situated approximately on the axis (pls. 22, 24, 26; fig. 102). Its maximum differential elevation is about 200 feet. From its northern terminus about six miles north of Marseilles its post-St. Peter axis trends S. 55° E. for a few miles, thence S. 30-35° E. to about six miles north of Dwight, thence almost due south to Saunemin, and thence, S. 25-30° E. to Chatsworth. Its pre-St. Peter axis trends almost due north along the west side of Grundy County nearly from Illinois River (fig. 102). The anticline plunges southward at the rate of about 15-20 feet to the mile.

*Kempton syncline.*—On the east side of the Dwight anticline there is a major structural depression for which the name Kempton is herein proposed after the town of Kempton, Ford County, which is situated approximately on its axis (pls. 22, 24, 26; fig. 102). The characteristics of this syncline have not been fully determined but it apparently extends laterally east as far as Buckingham, Kankakee County,[3] its axis is approximately parallel to the south part of the Dwight anticline, it pitches southeasterly, and it is depressed several hundred feet below the crest of the Dwight anticline.

*Oakdale syncline.*—The Dwight anticline is limited on the west by a syncline, herein named Oakdale because the well at Oakdale Women's Reformatory west of Dwight reveals the structure (pls. 22, 24, 26; fig. 102). The Oakdale syncline is a narrow shallow trough, trending about S. 35°-40° E. from north of Illinois Valley to a few miles northwest of Dwight, thence almost due south past the reformatory. It has a maximum depth of about 50 feet below the crests of the bordering anticlines and pitches gently southward.

*Odell anticline.*—The Oakdale syncline is limited on the west by a broad anticline, herein named Odell after the town of Odell, Livingston County, which is situated on the axis (pls. 15, 19, 22, 24, 26; fig. 102). The axis of the anticline is roughly parallel to and 15-20 miles east of the LaSalle anticline. It trends S. 10° E. from about five miles northwest of Sheridan to about three miles north of Marseilles, thence about S. 25-15° E. from Fox River through Marseilles to Odell, whence it trends almost due south to Fairbury. The anticline is slightly asymmetrical, the east limb being somewhat steeper than the west limb. Its maximum differential elevation where best developed is about 100 feet. It plunges southward about 25 feet per mile, gradually diminishing and disappearing near Fairbury.

*Ransom syncline.*—Lying between and essentially parallel to the LaSalle anticline on the west and the Odell anticline on the east is a broad syncline, herein named Ransom after the town of Ransom, Livingston County, which is situated on the axis (pls. 15, 19, 22, 24, 26; fig. 102). Its post-St. Peter axis trends S. 10° E. from the center of T. 37 N., R. 3 E., nearly to Ottawa, thence S. 25° E. from Ottawa to Ransom, whence it continues almost due south to Pontiac and thence S. 10-15° E. Its pre-St. Peter axis extends due north from Ransom. The differential elevation measured from the trough of the syncline at Pontiac to the crest of the LaSalle anticline due westward is between 250 and 300 feet and to the crest of the Odell anticline due eastward it is between 50 and 100 feet.

The syncline pitches to the south at the rate of from 25 to 50 feet per mile, apparently somewhat more steeply farther

[3]Athy, L. F., Geology and mineral resources of the Herscher quadrangle: Illinois Geol. Survey Bull. 55, fig. 27, p. 75, and pl. I, 1928.

south, where it becomes a major structural depression between the LaSalle and Dwight anticlines.

*Cedar Point anticline.*—A symmetrical anticline, herein named Cedar Point after the town of Cedar Point which is situated on its axis, trends S. 65° W. from the LaSalle anticline south of Oglesby (pls. 15, 19, 22, 24, 26; fig. 102). The average dip on both limbs is about 200 feet per mile near the LaSalle anticline and about 100 feet per mile west of Cedar Point. The maximum differential elevation between the deepest portion of the Granville basin and the crest of the anticline about a mile southeast of Cedar Point is probably about 250 to 300 feet. A pronounced sag in the structure extends from two miles south of Granville to just east of the Illinois River near Putnam, in which the crest is about 150 feet lower than the crest south of Cedar Point and 100 feet lower than the crest south of Putnam. The anticline is not discernible over the crest of the LaSalle anticline but is probably continuous with the Marseilles anticline (pls. 15, 19; fig. 102) farther east.

*Depue anticline.*—A low, narrow, symmetrical anticline, herein named Depue after the town of Depue, Bureau County, which is situated on its axis, trends and plunges about S. 45° E. from north of Princeton to a few miles southeast of Depue where it disappears (pls. 15, 19, 22, 24, 26; fig. 102). The maximum differential elevation of the anticline, measured from the Granville basin three miles west of Spring Valley to the crest at Depue, is between 100 and 150 feet.

*Hennepin syncline.*—Between the Cedar Point and Depue anticlines lies a broad syncline, herein named Hennepin after the town of Hennepin, Putnam County, which is situated on its axis (pls. 15, 19, 22, 24, 26; fig. 102). The syncline trends and pitches eastward.

*Peru anticline.*—A narrow anticline, herein named Peru after the town of Peru, LaSalle County, which is situated on its axis, trends S. 35° W. from the LaSalle anticline a mile northwest of LaSalle to a short distance south of the Illinois River, where it apparently disappears (pls. 15, 19, 22, 24, 26, 29; fig. 102). The fold plunges very steeply to the southwest on the west limb of the LaSalle anticline, but beyond that the plunge becomes much gentler, although more than 50 feet to the mile.

The maximum differential elevation is a little more than 100 feet. The fold is asymmetrical, with the dip of the southeast limb much steeper than that of the northwest limb, so steep in fact that it suggests the presence of a fault with the downthrow side on the southeast.

*Oglesby syncline.*—The structural depression that lies between the Cedar Point and Peru anticlines is herein named Oglesby syncline after the town of Oglesby, LaSalle County, which is situated in it. The syncline pitches steeply down the west limb of the LaSalle anticline and the sides dip strongly off the Cedar Point and Peru anticlines, but the trough of the structure is relatively flat with a gentle pitch westward (pls. 15, 19, 22, 24, 26; fig. 102).

*Spring Valley anticline.*—About two miles northwest of, and roughly parallel to, the Peru anticline there is a broad asymmetrical anticline, herein named Spring Valley after the town of Spring Valley, Bureau County, which is situated on its crest (pls. 15, 19, 22, 24, 26; fig. 102). The southeast limb of the anticline is much steeper than the northwest limb, which is hardly distinguishable from the west limb of the LaSalle anticline from which the anticline emerges. The anticline plunges gently southwestward.

*Star Union syncline.*—Between the Peru and Spring Valley anticlines there is a narrow syncline, herein named Star Union after the Star Union Brewery at Peru whose well reveals the magnitude of the structure (pls. 15, 19, 22, 24, 26; fig. 102). The syncline trends and pitches southwesterly parallel to the Peru anticline. It has a differential depression somewhat less than 50 feet.

*Seatonville syncline.*—Between the LaSalle and Depue anticlines there is a broad ovoid asymmetrical syncline, herein named Seatonville after the town of Seatonville, Bureau County, which is situated approximately on the axis of the structure (pls. 15, 19, 22, 24, 26; fig. 102). The trough of the syncline is 1600 feet below the crest of the LaSalle anticline but only 100-150 feet below the crest of the Depue anticline, so that its east limb is that much steeper than its west limb. The syncline pitches in an arc southwestward, southward, and southeastward from the Minick anticline in southeastern Lee County to Illinois River, the degree of pitch steadily declining. The breadth of the syncline also decreases from north to south, being most constricted between the termini of the Depue and Spring Valley anticlines.

*Granville basin.*—The Hennepin, Seatonville, Star Union, and Oglesby synclines all pitch and merge in a closed structural depression, herein named the Granville basin after the town of Granville, Putnam County, which is situated within it. The basin has a closure of about 50 feet, below the sag in the Cedar Point anticline. It has an irregular five-lobed shape as a consequence of the tributary synclines and the intervening anticlines that plunge into it (pls. 15, 19, 22, 24, 26).

*Minick anticline.*—A symmetrical anticline, herein named Minick after a farm in Lee County on which is located one of the wells that define it, trends about S. 45° W. from the LaSalle anticline, of which it is in effect a protrusion across southeastern Lee County. The limbs dip about 200 to 300 feet per mile on the flank of and about 50 to 100 feet per mile farther from the LaSalle anticline. The anticline plunges southwest more than 250 feet per mile on the flank of and 50 to 100 feet per mile farther from the LaSalle anticline. The differential elevation of the top of the St. Peter formation between the J. H. Buckley well No. 1 in the NW. ¼ of sec. 21, T. 19 N., R. 10 E. and the Minick well No. 1 in the NE. ¼ of sec. 17 is 508 feet, and is about the same for the other formations (pls. 15, 19, 22).

*Earlville sag.*—A broad, shallow syncline, herein named the Earlville sag after the town of Earlville, LaSalle County, which is situated approximately on and near the east end of its axis (pls. 15, 19, 22, 24; fig. 102), trends S. 75° W. from Earlville. It pitches gently in the same direction as far as the LaSalle anticline near Mendota, beyond which it pitches steeply down the west limb of the anticline. The sag is not only a major determinant of the present distribution of the Galena-Platteville formations in the vicinity of Mendota and Earlville (pl. 13) but also of the overlap of the Platteville strata on the St. Peter sandstone (p. 61).

*Oswego syncline.*—A broad, shallow syncline whose axis trends nearly due east-west across the north end of Kendall County is herein named Oswego after the town of Oswego that is situated nearly on its axis (pls. 22, 24; fig. 102). The syncline also pitches easterly and has a differential depression somewhat less than 50 feet.

*Aurora syncline.*—The southwest tip of a syncline trending northeasterly across the south end of Kane County, herein named Aurora because its axis passes near the city of that name (pl. 24, fig. 102), extends into the northwest township of Kendall County (T. 37 N., R. 6 E.), where it accounts for the presence of Silurian strata (pl. 13).

*Sandwich fault.*—In southeastern DeKalb and southern Kendall counties a fault, herein named Sandwich after the town of Sandwich, DeKalb County, through which it passes, strikes about S. 60° E. from Sandwich (pl. 13, 28). The downthrow side of the fault is to the northeast in amounts decreasing to the southeast: wells near Sandwich show that the Trempealeau dolomite abuts against the Galena-Platteville formations, representing a throw of 350 to 500 feet; of two wells only ⅛ mile apart near the center of sec. 4, T. 36 N., R. 6 E., southeast of Sandwich, the northeast one penetrated 234 feet of Galena-Platteville strata whereas the southwest one penetrated only 50 feet of glacial drift on top of the St. Peter, although the difference in their surface elevations is only about 5 feet, revealing a throw of 150 to 200 feet; south of Yorkville, a well in the southeast quarter of sec. 13, T. 36 N., R. 6 E., penetrated less than 55 feet of Platteville limestone whereas a well less than half a mile northwest penetrated 180 feet of Galena-Platteville limestone, and as there is only a slight difference in the surface elevations of the two wells, the throw there is therefore only 75 to 150 feet. It is possible that the fault dies out entirely in eastern Kendall County or western Will County, but it is believed that it probably continues as the fault zone existing near Millsdale in Will County.

*Stavanger syncline.*—The north end of the Dwight anticline is limited on the northeast by a shallow syncline, herein named Stavanger after the hamlet in eastern LaSalle County that is situated in the trough of the syncline (pls. 15, 19; fig. 102). The syncline trends S. 60° E. at first and then curves southward to S. 15° E. It is most pronounced in its northern part where it is depressed nearly 100 feet below the crest of the Dwight anticline and where it includes a basin with a closure of 20-30 feet (pl. 12). The south part of the syncline pitches southward in gradually lesser degree until it disappears south of Illinois Valley.

*Mendota anticline.*—The differential elevation of the Galesville sandstone at Pawpaw and Earlville and the absence of Shakopee and New Richmond formations at Mendota indicate the existence of a pre-St. Peter anticline, herein named Mendota after the town in LaSalle County that is apparently situated about on its axis (pl. 15; fig. 102). The anticline trends southwesterly from the Kankakee arch through northwestern LaSalle and southwestern DeKalb counties, and it plunges southwesterly from the Kankakee arch and northeasterly from the LaSalle anticline to form a sag northeast of Earlville. Originally it probably plunged continuously southwestward, but the raising of the LaSalle anticline reversed its trend in part.

*Morris syncline.*—Differential elevations of the surface and differences in thicknesses of pre-St. Peter formations (pls. 15, 18, 19, 20; fig. 102) indicate that a broad, shallow pre-St. Peter syncline trends S. 20-25° E. across Grundy County. It is herein named Morris after the town of that name which is situated on the axis of the syncline. The syncline has a differential depression of about 50 feet and pitches southeasterly from the Kankakee arch.

*Marseilles anticline.*—Another pre-St. Peter anticline, herein named Marseilles because it passes near the town of Marseilles, trends generally S. 70° W. from about eight miles north of Morris to about four miles north of Marseilles, whence it swings in a broad arc south and west about two miles south of Ottawa (pls. 15, 18, 19, 20). The maximum differential elevation on the top of the Galesville sandstone near Ottawa is about 100 feet. The anticline is nearly level and the limbs dip 50 to 100 feet per mile. It appears that southwest of Ottawa the anticline joins the Cedar Point anticline (fig. 102).

*Dayton syncline.*—The Marseilles anticline is limited on the west by a pre-St. Peter syncline, herein named Dayton after the town of Dayton, LaSalle County, which is situated on its axis, (pls. 15, 19; fig. 102). The syncline enters the region near Pawpaw and trends S. 55° E. to Fox River where it curves slightly west of south. It pitches in the same direction in increasing degree to attain a maximum depression near Ottawa, where it apparently terminates against the Marseilles anticline where the latter curves westward.

*Ottawa anticline.*—A symmetrical anticline, herein named Ottawa after the city of Ottawa which is situated on its axis, is most prominent in pre-St. Peter formations but persists in later formations (pls. 12, 15, 19, 22; fig. 102). It trends S. 20° E. through Ottawa, its limbs dip nearly 150 feet per mile, and it has a maximum elevation of about 250 feet.

*Other pre-St. Peter structures.*—Along Illinois Valley between Peru and Ottawa there are a number of small pre-St. Peter anticlines and synclines (pls. 18, 20; fig. 102), all of which trend S. 30-40° E. The two anticlines east of LaSalle appear to be steeper than the ones west of LaSalle, and their limbs dip about 50 feet per mile with a maximum differential elevation of about 75 feet. The folds apparently plunge and pitch northwesterly, but it is probable that there is a small amount of closure on each fold and that they plunge and pitch both northwesterly and southeasterly from the crest of the Marseilles-Cedar Point anticline.

*Minor flexures.*—Because more structural data are available for Pennsylvanian than for older strata, not only because they are penetrated by more borings but also because they are exposed in more numerous outcrops, both natural and artificial, small flexures that cannot be detected in the older, deeper formations can be mapped in the Pennsylvanian formations (pl. 12).

One of these small flexures is an anticline that trends southeasterly under Streator (pl. 12). It is a broad gently plunging anticline with a maximum differential elevation of about 50 feet and side dips up to about 20 feet per mile. Another similar anticline occurs about five miles north of Streator, and between the two anticlines is a consequent syncline of complementary magnitude.

A small narrow anticline and complementary syncline trends S. 20° E. across Illinois Valley just southwest of Ottawa. Their differential elevation is only 10-20 feet. At least two synclines, with complementary anticlines, appear to branch off of the Stavanger syncline northeast of Marseilles.

A similar minor anticline in beds older than Pennsylvanian occurs in the Galena-Platteville formations in the southwest corner of T. 37 N., R. 8 E., the northeast township of Kendall County. Its axis trends northwest-southeast and it has a differential elevation of about 20 feet (pl. 24).

*Joints, minor folds, and faults.*—Joint systems are rarely at right angles to each other, usually showing a variation of from 10° to 20° from the right angle.

There are two well-developed trends in the joint systems in the Marseilles, Ottawa, and Streator quadrangles—N. 50°-60° E., and N. 40° to 60° W. The first of these two systems is the better developed and is approximately at right angles to the trend of the axis of the LaSalle anticline, with which the second forms an angle of 20° to 40°. There are also other joint systems which are less pronounced and occur less frequently than the above (table 7). Of these, one (table 7, No. 11) may be of especial significance, as it may reflect the influence of the Cedar Point anticline.

Small, localized folds occur frequently in the Pennsylvanian rocks of the quadrangles. Good examples are well exposed in two localities east of Vermilionville: (1) along the ravine near the center of the SW. ¼ sec. 10, T. 33 N., R. 2 E. (Deer Park Twp.), Ottawa quadrangle; and (2) along the ravine south of the road in the SE. ¼, SE. ¼ NE. ¼ sec. 9, T. 33 N., R. 2 E. (Deer Park Twp.), Ottawa quadrangle.

Faults of small displacement are also common in the Pennsylvanian strata. Most of these are normal faults, but a small thrust fault with about 2 feet of displacement cuts Pennsylvanian strata along the west side of Covel Creek in the SE. ¼ SE. ¼ SW. ¼ sec. 26, T. 33 N., R. 3 E. (South Ottawa Twp.), Ottawa quadrangle. A fault with a displacement of about 10 feet causes repetition of Summum and St. David strata along the ravine southeast of Dayton in the SW. ¼ SE. ¼ NE. ¼ sec. 32, T. 34 N., R. 4 E. (Rutland Twp.), Ottawa quadrangle.

Table 7.—Trend of Joint Systems

| No. | ¼ | ¼ | ¼ | Sec. | Twp. | Range | Quadrangle | Formation | NE trend | NW trend |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | SW | SE | NE | 21 | 33 N | 5 E | Marseilles | St. David "slate" | N 50 E | N 60 W |
| 2 | SE | NW | NE | 24 | 33 N | 4 E | Marseilles | St. David "slate" | N 60 E | N 45 W |
| 3 | NW | NE | NE | 14 | 33 N | 4 E | Marseilles | St. David "slate" | N 50 E | N 60 W |
| 4 | NE | NE | NE | 2 | 33 N | 3 E | Ottawa | St. David "slate" | N 50 E | N 45 W |
| 5 | SW | SW | SW | 3 | 33 N | 3 E | Ottawa | St. David "slate" | N 50 E | N 40 W |
| 6 | SW | NW | SW | 27 | 33 N | 3 E | Ottawa | St. David "slate" | N 50 E | N 50 W |
| 7 | NW | NE | NE | 26 | 33 N | 2 E | Ottawa | St. Peter sandstone | N 50 E | |
| 8 | SE | SE | SE | 22 | 33 N | 2 E | Ottawa | St. Peter sandstone | N 50 E | |
| 9 | NE | SE | SE | 22 | 33 N | 2 E | Ottawa | St. Peter sandstone | N 50 E | |
| 10 | SW | NE | SE | 15 | 32 N | 2 E | Streator | St. David "slate" | N 50 E | N 50 W |
| 11 | SW | NE | SE | 8 | 32 N | 2 E | LaSalle | Galena limestone | N 30 E<br>N 15 E | N 70 W*<br>N 30 W |
| 12 | SW | NW | NW | 31 | 32 N | 3 E | Streator | Summum "slate" | N 50 E | N 45 W |
| 13 | SW | SW | SE | 32 | 32 N | 3 E | Streator | St. David "slate" | N 50 E | N 45 W<br>N 20 W† |
| 14 | NE | NE | NE | 16 | 31 N | 3 E | Streator | Brereton "slate" | N 60 E | N 50 W<br>E—W† |

*Most prominent.
†Weak.

# CHAPTER VII—GEOLOGIC HISTORY PRE-PENNSYLVANIAN

BY

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## INTRODUCTION

Geologic history tells the story of a changing earth—once mountains rose loftily where now lie flat prairies, broad sea-covered areas are the highlands of today, and thousands of feet of glacial ice buried the present sites of towering cities. This history has slowly unfolded as studies of the rocks have been extended throughout the world and as the events which they record have been interpreted in the light of knowledge derived from studies of earth processes active today. In the erosion by present streams, in the transportation and deposition of rock debris in rivers, lakes, and seas, in the action of volcanoes, in the erosion by glaciers and the deposition of moraines, in the formation of sand dunes along the shores of lakes and seas, we may observe rocks in the actual process of destruction and of formation and may determine the characteristics imposed by each environment. When we find the same characteristics in the ancient strata it is therefore possible to visualize the conditions that existed in those pre-historic times. Through countless ages these processes, now slowly molding the surface of the earth, have been actively wearing away the rocks in one area, building new ones in another.

Gravel, sand, silt, clay, and mineral matter in solution have been transported, worked over and assorted, and deposited beneath the seas, the coarser material being generally deposited near the shore and the finer farther from it. After consolidation by compaction and cementation, gravel becomes conglomerate, sand becomes sandstone, silt becomes siltstone, clay becomes shale, and chemical precipitates and organic secretions of calcium carbonate become limestone, or dolomite if mixed with magnesium carbonate.

Cross-bedding, ripple- and rill-marks, channel-fills, etc., record water movements, and together with mud-cracks, rain-drop impressions, and worm-borings they record shallow-water conditions, beaches, and tidal flats. Widespread limestone formations indicate that the continents adjacent to the sea in which the limestone was deposited were low or that the place of deposition was far from the shore; coarse clastic sediments indicate that the continents were high or that the shore was near the place of deposition.

Warped, folded, or faulted strata record earth movements. Erosion between two epochs of marine deposition is recorded by irregular contacts (unconformities) between the formations deposited during those epochs, by evidence of weathering in the upper part of the older formation, by residual detritus in the base of the upper formation, or by the occurrence in the younger formation of fossils of organisms more advanced in their evolution than those in the older formation. In fact, the history of life development is traced by the changes in life forms revealed by the fossils in successively younger formations.

The lowest rocks in the geologic sequence (table 8) reveal the oldest chapter of geologic history, and the successively higher rocks provide an orderly record of the changing conditions. Needless to say, many events in earth history are obscure, and like much of early human history, their records have been destroyed by later events. The geologic history of Illinois is read partly from rock outcrops and partly from records of wells and borings within the State and is supplemented by knowledge derived in the same way from adjacent regions. The sequence of rocks in the Marseilles-Ottawa-Streator area described in the chapters on stratigraphy is the principal source for the local history, although it has been supplemented by data from other areas, because processes which were operative within the area were generally also operative over considerable areas outside.

## PRE-PALEOZOIC ERAS

Pre-Cambrian history is at best obscure, and in areas such as the Marseilles-Ottawa-Streator area where the pre-Cambrian rocks are deeply buried, it must be largely inferred. In areas where the pre-Cambrian strata are well exposed, as in the Lake Superior district, they record a series of periods of deposition of sediments alternating with periods of erosion, folding, and metamorphism—all interspersed with numerous occasions of widespread igneous activity. It is probable that a similar series of events took place in Illinois and in the Marseilles-Ottawa-Streator area. A long period of erosion immediately preceding the Paleozoic era developed the pre-Cambrian peneplain known in Wisconsin.[1] The present southward slope of the peneplain is due partly to the original slope of the plain, but mainly to subsequent diastrophic movements.

## PALEOZOIC ERA

The Marseilles, Ottawa, and Streator quadrangles lie within the Central Interior basin. This basin was low-lying throughout the Paleozoic era and was frequently flooded by epicontinental seas. The intermittent elevation and depression of the area relative to sea-level created alternate epochs of erosion and deposition, the strand line varying radically many times and probably undergoing a minor amount of variation constantly. The sediments deposited in the area were derived chiefly from the Lake Superior region on the north, with minor contributions from the Ozark highland on the southwest and from the Appalachian highland on the east. Changes in deposition are recorded in discordant or unconformable strata, changes in lithology, and changes in fauna as revealed by fossils in the rocks.

[1]Wiedman, S. and Schultz, A. R., Water supplies of Wisconsin: Wisconsin Geol. and Nat. Hist. Survey Bull. XXXV, p. 26, 1915.

## CAMBRIAN PERIOD

The long period of erosion that closed the pre-Cambrian evidently continued through early and middle Cambrian time in the Central Interior basin in Illinois as there are no formations of these ages known in the State. But by late Cambrian time the lowland was submerged, and sediments now comprising the St. Croixan series were deposited. Conditions of deposition were highly variable from time to time, and hence there is a wide variation in the lithology of sediments deposited. As the formations thicken to the south, and as the sediments to the south are more typical of offshore deposits than those to the north, it is believed that the sea encroached from the south.

### Mt. Simon Stage

The first deposits in the advancing sea were the coarse sands and conglomerates of the Mt. Simon formation. The five fairly well defined zones of the Mt. Simon (p. 54, fig. 31) reflect distinct but minor changes in the source of the sediments or conditions of deposition. The basal arkosic member may be a terrestrial rather than a submarine deposit, and it may be older than Mt. Simon in age (p. 54).

### Eau Claire Stage

An abrupt and more important change in conditions brought about the deposition of the finer sands, dolomites, and shales of the Eau Claire formation. A peculiar depositional environment must have existed at the beginning of Eau Claire time to cause the precipitation of the finely divided pyrite which encrusts the grains of sand in the lowest zone. Possibly conditions were much the same as in the Black Sea[2] of today where the combination of stagnation and the activity of certain organisms gives rise to the precipitation of finely divided pyrite. The abundance of linguloid brachiopod and trilobite remains in this zone suggests

[2]Andruscow, N., La Mer Noir: Guide des excursion de 7 Cong. Geol. Internat. No. 27, 1897.

TABLE 8.—GENERAL CLASSIFICATION OF GEOLOGIC TIME

| Era | Subera | Period | Epoch | Subepoch | Stage |
|---|---|---|---|---|---|
| Cenozoic | Quaternary | Pleistocene | Eldoran | | *Recent<br>*Wisconsin |
| | | | Centralian | | *Sangamon<br>*Illinoian |
| | | | Ottumwan | | Yarmouth<br>*Kansan |
| | | | Grandian | | **Aftonian<br>Nebraskan |
| | **Tertiary | Pliocene<br>Miocene<br>Oligocene<br>Eocene | | | |
| Mesozoic | | Cretaceous<br>Jurassic<br>Triassic | | | |
| Paleozoic | | Permian | | | |
| | | Pennsylvanian | | *McLeansboro<br>*Carbondale<br>*Tradewater<br>**Caseyville | |
| | | Mississippian | Chester | | |
| | | | Iowa | Meramec<br>Osage<br>*Kinderhook | |
| | | *Devonian | Chautauquan<br>Senecan<br>Erian<br>Ulsterian<br>Oriskanian<br>Helderbergian | | |
| | | Silurian | Cayugan | | |
| | | | *Niagaran | | Port Byron<br>Racine<br>Waukesha<br>Joliet |
| | | | *Alexandrian | | Kankakee<br>Edgewood |
| | | Ordovician | Cincinnatian | | *Maquoketa |
| | | | Mohawkian | | *Galena<br>*Decorah<br>*Platteville<br>*Glenwood |
| | | | Chazyan | | *St. Peter |
| | | | Prairie du Chien | | *Shakopee<br>*New Richmond<br>*Oneota |
| | | Cambrian | St. Croixan | | *Jordan<br>*Trempealeau<br>*Franconia |
| | | | | Dresbach | *Galesville<br>*Eau Claire<br>*Mt. Simon |
| Proterozoic (Algonkian) | | Keweenawan<br>Huronian | | | |
| Archeozoic (Archean) | | Keewatin | | | |

*Formations and larger divisions definitely identified in North Central Illinois.
**Formations and larger divisions possibly present in North Central Illinois.

decimation of these organisms due to the high salinity of the water. Succeeding the deposition of the first zone was a period during which finer sand, mud, and calcareous material were deposited, with the proportionate amount of calcareous material increasing toward the end of the Eau Claire stage. As glauconite is believed to be the result of organic activity,[3] which is discouraged by relatively rapid sedimentation, the occurrence of abundant glauconite in the Eau Claire formation is thought to indicate relatively slow deposition.

#### Galesville Stage

Conditions similar to those of the Mt. Simon stage recurred during the deposition of the coarse sands of the Galesville formation, although the presence of some calcareous materials probably indicates that the waters in which they were deposited were more quiescent. Minor local movements are reflected in the variations in thickness of the Galesville.

#### Franconia Stage

After the deposition of the Galesville formation the conditions again changed to favor the deposition of the finer sand, shale, and dolomite, and abundant glauconite of the Franconia formation. There was some reworking of the Galesville sand so that the basal Franconia strata are similar in texture to those of the Galesville but differ in that they contain appreciable amounts of glauconite.

#### Trempealeau Stage

During Trempealeau time the seas cleared and in them were deposited chemical or organic precipitates or both which later became the dolomite of the formation. The three well-defined glauconitic zones (see Chapter I) again probably represent periods of slower deposition. The chert that is present in the formation may be primary, that is, deposited as colloidal silica at the same time as the rest of the formation, or it may be secondary, that is, have replaced the dolomite subsequent to the consolidation of the formation.

[3]Twenhofel, W. H., Treatise on sedimentation (1st ed.), pp. 337-341, 1926.

#### Jordan Stage

At the beginning of the Jordan stage there was a retreat of the sea or some uplift of the bordering land mass to account for the sand that occurs at the base of the formation. During the Jordan stage there were very minor advances and retreats of the sea giving rise to alternating layers of clastic and calcareous sediments.

The Cambrian period in the Central Interior basin was terminated by an uplift of the region above sea-level and a succeeding period of erosion during which the Jordan formation was deeply eroded.

## ORDOVICIAN PERIOD

### PRAIRIE DU CHIEN EPOCH

#### Oneota Stage

The Ordovician period began with a readvance of the sea. During the Oneota stage the sea was relatively clear as indicated by the dominantly calcareous material that composes the formation. Sometime near the middle of the stage, conditions were altered so that the deposition of glauconite took place. In the latter part of the stage the addition of clastic material became marked and was probably a forecast of the conditions that were to be attained during the New Richmond stage.

#### New Richmond Stage

Either after the Oneota and before the New Richmond stage or during the New Richmond stage, the Marseilles anticline began to rise, accompanied by some movement along the subsidiary anticlines. The movement of this anticline continued at intermittent intervals throughout New Richmond, Shakopee, and St. Peter times, as shown by the thinning of these formations over the anticline. Formations younger than the St. Peter, other than Pennsylvanian and Pleistocene, have been removed or deeply eroded so that there is no direct evidence whether or not the movements continued after St. Peter time. However, if the Marseilles anticline is a continuation of the Cedar Point anticline, the movements of the latter are indirect evidence that the former continued to rise until at least the end of the Silurian period.

The conditions of deposition favored the accumulation of sand throughout most of the New Richmond stage, but at intervals conditions locally favored the deposition of calcareous material.

### Shakopee Stage

After the deposition of the New Richmond sand there was a marked clearing of the seas with conditions again favorable for the accumulation of calcareous material. Evidence of shallow-water deposition during the Shakopee stage is found near Franklin Grove, Lee County,[4] and in the LaSalle quadrangle.[5]

### Post-Shakopee Pre-St. Peter Interval

The close of the Prairie du Chien epoch was marked by the uplift of the Kankakee Arch[6] and related structures, such as the Marseilles and Mendota anticlines and the small anticlines across Illinois Valley (pls. 15, 19, fig. 106), as well as minor flexures elsewhere present in the Shakopee but not in the St. Peter formation[7]. These movements were accompanied or immediately followed by widespread erosion which removed all of the Shakopee and New Richmond formations and much of the Oneota formation in the uplifted portion of Illinois northeast of the arch, truncating these formations as they rise on the southwest limb of the arch (pls. 13, 18, 19, 20), and cut into the lower formations down at least as far as the Trempealeau. The erosion apparently occurred in two stages, the first being carried to virtual peneplanation in the uplifted northeastern region and the second, a rejuvenation, carried well into youth or early maturity.

A well-developed river system was formed in the eastern part of Livingston and southern part of Grundy counties (pl. 21), the data available indicating that the stream flowed to the southwest. This river system extended headward at least as far as Joliet.[8] A deep tributary to it, flowing either south or east, crosses Grundy County at Morris (app. C, 17 and pls. 18, 20, 21, 28, 29). Other tributaries are also evident. Recent studies in the Elgin, Barrington, and Geneva quadrangles show that another large river system drained eastward across that area.[9]

## CHAZYAN EPOCH

### St. Peter Stage

The Chazyan epoch opened with a readvance of the sea over a region having erosional topography and a mantle of regolith of varying thickness. This residual material was reworked by the advancing St. Peter sea and formed the initial deposit of the Chazyan epoch.

Conditions remained stable throughout the deposition of the St. Peter as reflected in the succession of sand that composes the formation. The characteristic rounding and frosting of the sand grains have been cited as evidence that the formation is mainly an eolian deposit, possibly in a desert adjacent to the sea, but other evidence demonstrates that it is mainly marine, and the grain characteristics are probably the result of a long and complex history involving many earlier cycles of erosion and deposition.[10,11] Some recurrent uplift of the Marseilles anticline during the St. Peter stage is reflected in the thinning of the St. Peter sandstone over it. The St. Peter stage was terminated by a slight, apparently local, emergence, probably accompanied by some local folding, as there is evidence of an erosional unconformity between the St. Peter and overlying Platteville or Glenwood beds in some areas[12] and of an overlap in the vicinity of LaSalle and Ottawa (p. 61), whereas at other places there seem to be transitional beds between the St. Peter and overlying Glenwood formations.[13] The

[4]Knappen, R. S., Geology and mineral resources of the Dixon quadrangle: Illinois Geol. Survey Bull. 49, pp. 82-85, 1926.

[5]Cady, G. H., Geology and mineral resources of the Hennepin and LaSalle quadrangles: Illinois Geol. Survey Bull. 37, p. 92, 1919.

[6]Ekblaw, George E., Kankakee arch in Illinois: Geol. Soc. America Bull. vol. 45, pp. 1425-1430, 1938.

[7]Cady, G. H., Structure of the LaSalle anticline: Illinois Geol. Survey Bull. 36, pp. 111-112, 1920.

[8]Fisher, D. J., The geology and mineral resources of the Joliet quadrangle: Illinois Geol. Survey Bull. 50, pp. 14-20, pl. III, 1925.

[9]Gries, P., Subsurface geology of Elgin, Geneva, and Barrington quadrangles: Illinois Geol. Survey unpublished manuscript.

[10]Dake, C. L., The problem of the St. Peter sandstone: Univ. of Missouri School of Mines and Metallurgy Bull., tech. series, VI, No. 1, 1921.

[11]Lamar, J. E., Geology and economic resources of the St. Peter sandstone: Illinois Geol. Survey Bull. 53, pp. 26-29, 1928.

[12]Elder, Stanley G., Stratigraphy of the Glenwood formation: Illinois Geol. Survey unpublished manuscript.

[13]Bevan, A. C., The Glenwood beds as a horizon marker at the base of the Platteville: Illinois Geol. Survey Rpt. Inv. 9, 1926.

overlap is apparently the result of uplift along the Marseilles anticline and other smaller anticlines at the close of the St. Peter stage, sufficient to make a local land area in Glenwood and early Platteville times, and is probably not the result of movement of the LaSalle anticline before the beginning of Mohawkian time as has been cited.[14]

### MOHAWKIAN EPOCH

#### Glenwood Stage

After the brief and local emergence of land at the close of the St. Peter stage the sea again inundated the area, reworking the St. Peter sand and depositing additional fine material to create what is called the "typical Glenwood texture". In addition some mud was locally deposited and now forms the shale of the formation. In the late part of the Glenwood stage the seas became clearer and calcareous material with some admixed clastic detrital materials was deposited.

#### Galena-Platteville Stages

Gradually the sea became still clearer, and calcareous material with no sand and very little mud was deposited during the Platteville-Galena stages. There was a slight fluctuation of conditions during the Decorah stage, however, which brought about the contribution of some detrital material which gave rise to the shale partings and the argillaceous and rarely sandy character of the formation. Also conditions existed locally which were favorable to the deposition of oölites. It is believed that dolomitization of all the formations took place after their deposition and consolidation.

The Mohawkian epoch was closed by slight uplift of the region.

### CINCINNATIAN EPOCH

After a short period of emergence after the Mohawkian epoch, the Marseilles-Ottawa-Streator area was again submerged by a sea that advanced from the north.[16] Conditions at the beginning and in the earliest part of the Maquoketa stage favored the accumulation of silt and mud with a minor amount of calcareous sediment; in the middle of the stage, the seas became clearer and the deposition of calcareous material became dominant; and during the last part of the stage, conditions reverted to those which existed in the earliest part so that again much mud and silt with negligible amounts of calcareous material were deposited.

Either during or at the close of the Maquoketa stage the Cedar Point anticline was elevated, as shown by the pronounced thinning of the Maquoketa formation in the well at Cedar Point (pl. 25).

The Ordovician period was closed by an elevation of the entire region above sea-level, followed by erosion of the Maquoketa formation.

## SILURIAN PERIOD

### ALEXANDRIAN EPOCH

After an erosional interval of long duration the area was again inundated in the Alexandrian epoch by waters that advanced from the Gulf of Mexico.[17] During the early part of the epoch, in the Edgewood stage, the material deposited was largely clastic, but later, during the Kankakee stage, the seas became very clear and little or no clastic material was deposited. In the latter part of the Kankakee stage the water was probably clearer than at any other time in the Silurian period, because in other parts of northern Illinois insoluble residues are practically absent from the top of the Kankakee formation.[18]

### NIAGARAN EPOCH

There was a shallowing of the seas at the beginning of the Niagaran epoch, and a marked increase of clastic material was contributed to the sediments. At this time a connection was established with

[14] Cady, G. H., op. cit., Bull. 36, p. 175.
[16] Savage, T. E., Richmond rocks of Iowa and Illinois: Am. Jour. Sci., 5th Ser., vol. 8, pp. 411-427, 1924.
[17] Savage, T. E., Silurian rocks of Illinois: Geol. Soc. America Bull., vol. 37, pp. 513-534, 1926.
[18] Workman, L. E., personal communication.

seas to the north.[19] After the earliest part of the Niagaran epoch the seas became clearer and the amount of clastic material decreased. The widespread chert that occurs in the Niagaran series was formed partly by precipitation from circulating groundwaters subsequent to consolidation of the dolomite and partly by direct precipitation from the sea-water during the deposition of the calcareous material.[20]

The Niagaran epoch was closed by widespread emergence, accompanied by a recurrent movement along the Cedar Point anticline as reflected in the thinning of the Silurian system. The region remained land throughout the Late Silurian epoch, for there are no deposits of this age known within the area.

## DEVONIAN PERIOD

The land conditions that existed in Illinois during the Late Silurian epoch probably continued through the Early and Middle Devonian epochs, as the Devonian rocks in the area are believed to be of Late Devonian age. The area was probably submerged by the Late Devonian sea, and conditions favored the accumulation of calcareous material with a minor amount of mud.

The Devonian period ended with the emergence of the area.

[19]Savage, T. E., Alexandrian rocks of Illinois and Wisconsin: Geol. Soc. America Bull., vol. 27, p. 314, 1916.

[20]Fisher, D. J., Geology and the mineral resources of the Joliet quadrangle: Illinois Geol. Survey Bull. 51, pp. 41-44, 1925.

## POST-DEVONIAN PRE-PENNSYLVANIAN TIME

Little is known of the events that took place in north-central Illinois between the close of the Devonian and the opening of the Pennsylvanian periods. Although Mississippian rocks are found in the Henry city well, it is possible that the Mississippian seas never advanced completely over the region.

Sometime between the close of the Devonian and the beginning of the Pennsylvanian periods the major folding of the LaSalle anticline took place. From evidence in areas to the south, it seems probable that this deformation took place in late Mississippian time.[21]

The rise of the Depue, Dwight, and Odell anticlines and additional movement along the Kankakee arch, accounting for the exposure of Cambrian rocks near Millington, and other pre-existing folds, took place at this time. The Sandwich fault was probably formed as a result of subsequent relaxational movements. In late or post-Pennsylvanian time there was a second and more intense period or periods of compression which marked the climax of the folding of the LaSalle anticline. Probably all of the structural units involved in the first period of folding were again affected.

[21]Payne, J. Norman, The Age of the LaSalle anticline: Trans. Illinois Acad. Sci. vol. 32, No. 2, 1940; Illinois Geol. Survey Circular 60, pp. 5-7, 1940.

ERRATUM

Page 195, second column, last paragraph, fourth line.

*The phrase:*

"the exposure of Cambrian rocks"

*should be changed to read:*

"the exposure of Ordovician rocks"

# CHAPTER VIII—GEOLOGIC HISTORY—PENNSYLVANIAN AND LATER

BY

H. B. Willman

## PALEOZOIC ERA

## PENNSYLVANIAN PERIOD

With the beginning of Pennsylvanian time, conditions controlling sedimentation had changed notably, and the character of the deposits which accumulated differed greatly from earlier Paleozoic deposits.[1] Many of the earlier formations are distinguished by great thicknesses of one kind of material, indicating long-continued stable relations in the distribution of land and sea. During Pennsylvanian time many different kinds of rocks were formed and, although material of each kind was deposited at many times, the individual units of each kind of rock are comparatively thin. Some of the units are as much as or more than 100 feet thick but most of them are only a few feet or even only a few inches thick. The great variety of materials present is in part due to the accumulation of the deposits under alternating marine and nonmarine conditions, and cyclical repetition gave rise to the sequences of deposits termed cyclothems (p. 87). That these changing conditions were not local is shown by the great lateral extent of individual beds. For instance, many beds of coal, nonmarine in origin, and of marine limestones occur throughout the Illinois basin, and it seems probable that eventually correlation will show that some beds extend throughout the coal basins from Pennsylvania to Texas.

Throughout Pennsylvanian times, highland areas known as Appalachia and Llanoria existed respectively along the east and south parts of North America. The interior part of the continent was a plain that repeatedly was submerged by the sea or lay a short distance above it, depending on slight changes in the elevation of the land with respect to sea-level. When the sea submerged the plain, it gradually advanced from the southwest around the west end of Llanoria, and on many occasions it advanced eastward as far as Pennsylvania. Rivers and streams carried rock debris into the sea, mostly from Appalachia and Llanoria but perhaps some from land areas to the north and west. The resulting deposits therefore accumulated in a marine environment. When the sea receded, deposition continued but the deposits were laid down under terrestrial conditions. The newly emerged plain was eventually covered by swamps that stretched unbroken for hundreds of miles and in which flourished a luxuriant vegetation. The deposits of each complete cycle, therefore, are partly marine and partly terrestrial in origin.

Many notable changes occurred in the evolution of life during Pennsylvanian time. On the lands the plants, especially the swamp-dwelling forms, developed in great profusion. The first insects appeared and giant dragonflies with a wing spread of more than 2 feet and cockroaches 3 to 4 inches long were outstanding inhabitants of the forests. The amphibia, the first vertebrates to invade the lands, who first appeared in Devonian time, developed in great numbers and in great variety. Some of the larger were 5 feet

[1]Wanless, H. R., Geology and mineral resources of the Alexis quadrangle: Illinois Geol. Survey Bull. 57, pp. 121-124, 1929.

Weller, J. M., Cyclical sedimentation of the Pennsylvanian period and its significance: Jour. Geology, vol. 38, pp. 97-135, 1930.

Giles, A. W., Pennsylvanian climates and paleontology: Am. Assoc. Petroleum Geologists Bull., vol. 14, pp. 1279-1299, 1930.

Weller, J. M., The conception of cyclical sedimentation during the Pennsylvanian period: Illinois Geol. Survey Bull. 60, pp. 163-177, 1931.

Wanless, H. R., and Shepard, F. P., Sea level and climatic changes related to late Paleozoic cycles: Geol. Soc. America Bull., vol. 47, pp. 1177-1206, 1936.

long, and many of them were armored with plates and scales. Late in Pennsylvanian times they gave rise to the first of the reptiles. In the seas the brachiopods were the most abundant of the invertebrates, and perhaps the most characteristic forms of the time were the spiny-shelled productids. Gastropods and pelecypods were also present in great numbers (pl. 30). Of the foraminifera, the fusulinids, whose small shells are shaped much like a grain of wheat, were abundant at times.

## History of a Cyclothem

The base of the cyclothem, and therefore the beginning of the deposition cycle which it records, has been selected as the change from marine to what is considered terrestrial sedimentation. It not infrequently is marked by an unconformity represented by channels eroded by the streams as they extended their courses across the emerging plain to reach the receding sea. The channels were seldom eroded completely through the underlying cyclothem although locally they cut through one and rarely through two or three cyclothems. Usually, however, they cut through 25 to 50 feet of shale and their maximum depth is usually near the level of the black shale or coal of the underlying cyclothem. The interval of erosion was apparently not long, as no soils have been found and there is no evidence of leaching in calcareous materials where they are cut by the channels.

During or shortly after erosion of the channels the streams began filling them with sand and silt, some of which was locally carried into the receding sea and deposited without notable break above the previous marine sediments. When the channels were filled, the sand and silt was spread over the flat plain and increasingly finer and more argillaceous sediments were deposited so that not uncommonly sandy or silty shale occurs in the upper part or overlying the basal sandstone of a cyclothem. The poor sorting, the irregular bedding, the abundance of plant debris, and the presence of local coal beds indicate that the sandstone accumulated in a terrestrial environment.

The conditions succeeding the deposition of the sand and silt have not been satisfactorily interpreted as yet, but judging from the physical character of the underclay that accumulated, its widespread distribution, its uniformity, its calcareous content and associated nodules, lenses, and beds of limestone, its scarcity of fossils, and the presence of rootlets, the conditions must have been uniform over great expanses; they were such that only fine-grained clastic materials, accompanied by more or less calcareous material, were deposited, and they were unfavorable for the establishment of life. The presence of calcareous material, the existence of some persistent beds of limestone, and the presence of some fossils of *Spirorbis* indicate that the deposits were made in water. The scarcity of fossils may indicate that conditions were unfavorable for their preservation but the calcareous marine shales usually contain fossils, and consequently their absence from the underclays suggests that the conditions in the water were unfavorable for the establishment of any special form of life. A possible explanation is a frequent alternation of fresh and brackish water, and, if true, this implies a large expanse of shallow water essentially at sea-level and closely associated with the sea.

The conditions favoring the accumulation of clay eventually changed to those of an enormous fresh-water swamp in which a luxuriant and diversified forest flourished under a climate thought to have been warm and humid. When the plants died they fell into the swamp and, protected by the water from aerial decay, accumulated as peat, later to become coal. The upper few inches of the underlying clay in which the plants were rooted, at least during the initial stages of the formation of the peat, were leached, possibly by the waters charged with organic acids, and the carbonates so leached from the upper part were sometimes deposited as nodules lower in the underclay. During the accumulation of the peat, the land areas surrounding the swamps must have been relatively very low, as usually only a minor quantity of very fine clay was included in the peat (now ash in the coal), but at times thin beds of clay accumulated and now form partings in the coal. The time required for the accumulation of the peat was probably variable because of differences in the abundance of plants and in conditions for their preservation. It has been estimated that the accumulation of sufficient peat to form one foot of bituminous coal requires about 300 years,[2] and, if so, a coal like the widely persistent LaSalle (No. 2) coal may represent an interval of about 1,000 years.

The great wooded swamps were destroyed and the nonmarine part of the sedimentary cycle was terminated by an invasion of the sea. Some of the gray shales immediately overlying the coals have an abundance of plants and may have accumulated in fresh water before the sea invasion, but commonly the shales over the coal are black and carbonaceous and contain an abundance of marine fossils that show they were deposited as marine muds. A large amount of finely disseminated carbonaceous material, which may have been derived from the adjacent forested lands which were not inundated, was deposited with the clay. The preservation of the organic debris has been interpreted as indicating stagnant-water conditions but the abundance of bottom-living invertebrates, especially pelecypods, indicates the environment was inhabitable. The uniform thickness, the persistent lateral extent, and the sharp differentiations of the thin hard beds of the black shales may have been caused by seasonal variations. The bedding-planes may mark intervals during which sedimentation practically ceased and partial compaction of the last deposit preceded deposition of a new layer. If the seasonal variations were annual, the time involved in the formation of 2 feet of black shale would be 1,000 to 1,200 years.

After deposition of the black muds, conditions changed and the seas were occupied by an abundant and varied invertebrate fauna whose remains combined with chemically precipitated calcium carbonate to form limestone. However, some clay was being carried into the sea, so that many of the limestone beds are argillaceous or even grade laterally into calcareous clay or shale. In some cycles the predominance of clay or lime mud changed repeatedly so that alternating bands of limestone and shale were formed. The brecciated character of some of the limestones suggests that the seas were shallow enough for wave-action to break up the slightly consolidated deposits.

The calcareous deposition was succeeded by the accumulation of beds of clay, represented by the shale overlying the limestone. The change of conditions was gradual, sometimes with temporary recurrences of the conditions favoring calcareous deposition as shown by limestone bands in the lower part of the shale. The conditions continued to change gradually so that the deposits became more and more sandy. Although conditions were favorable for the preservation of the shells of invertebrates during the deposition of the lower part of the shale, fossils are usually absent in the upper sandy shale. These conditions apparently reveal a gradual recession of the sea which terminated one cycle and opened another.

In a general way the succession of events comprising a cycle, the advance and retreat of the sea, were repeated over and over during the Pennsylvanian period. However, the conditions were never exactly the same and consequently there are many variations in the sequence of deposits in the different cyclothems, the variable conditions being reflected in differences in thickness and composition or in the absence of some beds.

The areas in which the Pennsylvanian deposits were laid down are generally believed to have been depressed during Pennsylvanian times because of the great thickness of the Pennsylvanian strata and the presence of many shallow-water deposits and coal. However, the cause of the cyclical repetition of sea advance and retreat is uncertain, although several hypotheses have been offered. The relative changes of sea-level have been explained as due to: (1) repeated uplift and subsidence of the land, the subsidence greater than the uplift; (2) repeated subsidence without uplift, the change from marine to fresh-water conditions being attributed to filling of the shallow seas by sediments; (3) land stability, but fall and rise of the sea due to some exterior cause such as movements in the sea-bottom, or glaciation which would take water from the sea as the glaciers expanded and return the water when they melted; and (4) cli-

[2]Ashley, G. H., The maximum rate of deposition of coal: Econ. Geology, vol. 2, pp. 34-37, 1907.

matic changes. Each of these theories possesses some merit and some disadvantages and it is possible that a combination of these as well as other possible phenomena may have been responsible for the cycles.

The Marseilles-Ottawa-Streator area was affected by at least 15 of these cycles but because the succession of events in each cycle follows the general sequence already described, only the major events and those incidents which produced individual peculiarities in each cycle are discussed below.

### Pre-Liverpool Time

At the beginning of the Pennsylvanian period, the area was comparatively flat with a few gentle undulations mostly less than 15 feet deep. Most of it lay slightly higher than areas to the east and west because of its position along the axis of the LaSalle anticline, which had been almost but not completely beveled by the pre-Pennsylvanian erosion, so that it formed a peninsula protruding southward into the early Pennsylvanian seas. As a result no deposits were made in that area until the surrounding lower areas were filled. Sediments were being deposited in fairly regular cyclothems farther south and west and probably two or three of them, not now exposed, occur in the southwest part of the Streator quadrangle in what was then the lower area on the west side of the anticline. The variable sequence of clays below the LaSalle (No. 2) coal suggests that in this area the only representatives of several of these older cyclothems may be their underclays.

### Liverpool Cycle

In Liverpool time the pre-Pennsylvanian depressions were all filled, deposition was extended north of the area, and the sediments laid down throughout the area were essentially continuous with deposits in areas to the east, west, and south. However, the earliest deposit of the Liverpool cycle in the area, the basal sandstone, was deposited only in the south part of the Streator quadrangle and locally in the Ottawa and Marseilles quadrangles. The underclay of the cyclothem was the initial Pennsylvanian deposit in a large part of the area and it varies in thickness because it filled the shallow depressions in the pre-Pennsylvanian surface. In most of the Ottawa quadrangle and a large part of the Marseilles quadrangle the pre-Pennsylvanian surface was the loosely consolidated St. Peter sandstone, sand from which was mixed intimately with the clay or was deposited in more or less clayey lenses in the clay. As a result of the clay filling the depressions, the area became very flat so that swampy conditions which followed were widespread, and an unusually uniform thickness of peat, which became the LaSalle (No. 2) coal, accumulated in most of the area, although the regional conditions were such that the peat was generally thicker in the south and east parts of the area than in the north. Following the accumulation of the peat, the area was submerged by an advance of the sea in which large quantities of silty clay were deposited and formed the thick Francis Creek shale. Deposition of the clay ended Liverpool deposition in most of the Ottawa and Marseilles quadrangles but in the southwest part of the Ottawa quadrangle and in the Streator quadrangle deposition continued, and a black mud which became black shale was laid down. It was followed by the deposition of lime muds which formed limestone, and deposition of sandy clay marked the end of the cycle.

### Lowell Cycle

The Lowell cyclothem was deposited principally in the Streator quadrangle and the southwest part of the Ottawa quadrangle, although locally one or two members of the cyclothem were laid down elsewhere in the area. The beds were generally thinner northeast toward the margin of deposition, as shown in outcrops in the southwest part of the Ottawa quadrangle. Deposition was apparently more or less continuous from the Liverpool to the Lowell cycle, as there is no evidence of an unconformity at the base of the Lowell cyclothem and the basal Lowell siltstone is only slightly coarser grained than some of the beds in the uppermost shale of the Liverpool cyclothem. The siltstone, underclay, and coal of the cyclothem are commonly thin, indicating that nonmarine conditions apparently existed a much shorter time than during most of the cycles. Following the deposition of these beds, the sea again invaded the area and in it a few feet of alternating red and gray clays with a few thin beds of lime-mud were deposited.

### Summum Cycle

The first deposit of the Summum cycle in the Marseilles-Ottawa-Streator area was a generally thin layer of calcareous silt and very fine-grained sand, the equivalent of the thick Pleasantview sandstone in much of the Illinois basin farther south and southwest. There is no evidence in this area of the erosional interval represented by the well-developed unconformity at the base of the sandstone elsewhere in Illinois. During the deposition of the succeeding clay, conditions varied so that a series of greenish-gray, white, and black clays with a thin deposit of lime-mud accumulated before a typical gray underclay was laid down. During the succeeding swampy stage, conditions were not favorable throughout most of the area for the preservation of plant debris and so only an inch or two of the Summum (No. 4) coal is generally present, and at many places it is represented only by a thin bed of black shale with coaly streaks, but locally in the Streator quadrangle enough peat accumulated to make 2 to 3 feet of coal.

During the following invasion of the sea, black clay that later became hard blocky shale and black laminated clay that became sheety shale or "slate" were deposited in the Streator quadrangle and in the southwest part of the Ottawa quadrangle, and interbedded and mottled black and green clays that became relatively soft shales accumulated farther north and east. In the clays considerable quantities of calcareous and sideritic muds accumulated in thin lenses and discontinuous beds. Following the deposition of the black clays a clayey lime-mud, which became the Hanover limestone, was deposited almost continuously throughout the area. Locally the sea may have withdrawn temporarily after the deposition of the lime-mud, as the brecciated character of the upper part of the limestone suggests dessication fracturing of the slightly consolidated mud. The presence of phosphatic nodules along the top of the limestone also suggests withdrawal of the sea because they are commonly found along unconformities. A highly calcareous clay containing marine fossils was deposited on the limestone at many places and then a thin lime-mud with a distinctive ridged structure, probably algal in origin, was laid down in most of the Ottawa and Marseilles quadrangles. Near Marseilles and Ottawa a greenish-gray clay was laid down in thin beds above the algal limestone.

The last deposit of the Summum cycle was a thin lenticular bed of limestone pebbles and sand which was later consolidated to form the Covel conglomerate. The bed was probably formed in an environment not greatly different from that in which the Pennsylvanian lime-muds accumulated, as it locally contains many marine fossils, only a few of which are water-worn, but the origin of the pebbles is uncertain. Many of them appear to be algal accretions and others are broken and rounded fragments of limestone. The presence of pebbles of the underlying calcareous clay indicates their local derivation; the conglomeratic structure of the bed shows that most of the pebble material was already consolidated before deposition in the conglomerate; and the local sorting by grain size and the presence of pebbles of different types of limestone suggest that many of the pebbles were transported at least a short distance. However, they were probably not transported any great distance as many of them have nodular surfaces, not waterworn shapes, some are angular lath-shaped fragments, they are all of relatively soft materials, and many are large. The absence of mica and the scarcity of quartz sand and silt indicate that the materials were derived from a different area from that which supplied the Pennsylvanian sands, while the absence of dolomite and chert indicates that the materials were not derived from the pre-Pennsylvanian strata which presumably were exposed north of the area. After the conglomerate was deposited, a thin band of laminated limestone was locally deposited over the surface of the bed, probably by algae.

### St. David Cycle

The characteristic nonmarine deposits of most cyclothems were probably not deposited in the Marseilles-Ottawa-Streator area during the St. David cycle. The coal and underclay were deposited a short distance south of the area but the absence of the basal sandstone is a characteristic of the St. David cyclothem in most of Illinois.

The earliest deposit of St. David time was a thin laminated clay whose fossils suggest it was deposited in brackish-water, and it may be equivalent to the underclay farther south. After the deposition of the clay, the area was covered by marine waters in which was deposited about an inch of a distinctive black lime-mud crowded with the shells of *Marginifera*. Then a few inches of black mud, which became a soft black shale, was deposited before black mud was laid down in the thin laminae characteristic of black sheety shale or "slate." During the deposition of the first 2-3 inches of the black laminated mud, the pelecypod *Aviculopecten rectilaterarius* was so abundant that the sea-bottom was literally covered with their shells. Gradually the conditions favoring deposition of black mud changed to those favoring deposition of the gray mud that became the Canton shale. During the deposition of the lower part of the gray mud, marine gastropods and pelecypods lived in the area in great abundance and variety. Later a considerable quantity of plant debris was carried into the area and deposited along with some of the clay to form a bed of impure canneloid coal. Deposition of the gray mud continued with increasing amounts of fine sand and silt to the end of the St. David cycle.

### Brereton Cycle

At the beginning of the Brereton cycle broad and steep-walled channels as much as 60 feet deep were eroded in the Canton shale. Following and in part accompanying erosion of the channels large quantities of sand and silt were deposited in the area, completely filling the channels and accumulating to a considerable thickness in the intervening areas. Contrary to the usual sequence of events in a cycle, erosion was again active following the deposition of the sand, and deep channels were eroded in it so that locally it was reduced to a few feet thick. Two prominent channels in the top of the sandstone trending from northeast to southwest are exposed along Vermilion River in the Streator quadrangle (p. 125). In these channels a variable series of beds consisting of black and gray muds, a thin bed of coal, and lenses of clay and limestone was deposited. Except for plant impressions the fossils in these beds are mostly forms adapted to brackish water. Then swampy conditions prevailed and peat accumulated. Either because the previous deposits did not completely fill the channels or else compacted so as to leave depressions, a much greater thickness of peat accumulated along the channels, and as a result coal No. 6 is locally more than twice as thick over the channels as in the adjacent areas. The accumulation of plant debris was interrupted frequently by the deposition of thin beds of clay, which became partings in the coal. Compaction of the peat, perhaps with continued compaction of the underlying beds, left depressions along the channels which were partly filled with clayey silt.

When the sea advanced in the Brereton cycle, the channel at Klein Bridge had been less filled than that at Streator and a considerable thickness of black and gray marine muds accumulated in that area but were not laid down at Streator. Then lime-mud was deposited, probably more or less regularly throughout the entire area, but the continued effect of the depression at Klein Bridge may account for the unusually argillaceous character of the limestone and its general dissimilarity to the limestone at Streator and elsewhere in northern Illinois. During this interval a considerable variety of brachiopods and gastropods lived in the area. The Brereton cycle closed with the deposition of a few feet of mud.

### Sparland Cycle

Although the Sparland cyclothem occurs only in the south part of the Streator quadrangle, it is probable that the cyclothem was originally deposited throughout the area, following an interval of erosion. At the beginning of the Sparland cycle channels were eroded in the underlying beds. Although the depth of erosion was much less than that at the beginning of the Brereton cycle, it locally cut through the Brereton limestone. The basal sandstone was comparatively thin and was covered by clay on which accumulated the peat which was converted into coal No. 7. The peat was covered by clay which was probably marine, although no fossils have been found in this area. The clay became the Farmington shale.

### Gimlet Cycle

Erosion was active at the beginning of the Gimlet cycle and deep channels were cut into the Sparland strata. The Farmington shale was much reduced in thickness and locally both it and coal No. 7 were completely eroded. Sand was deposited on this eroded surface and covered by a series of green and red clays, the youngest Pennsylvanian deposits exposed in the area. Above this shale a thick limemud that became the Lonsdale limestone accumulated.

### Later Pennsylvanian Time

Above the Gimlet cyclothem a considerable thickness of Pennsylvanian strata was deposited throughout the Marseilles-Ottawa-Streator area, but these strata have been subsequently eroded so that they are now present only in the southwest corner of the Streator quadrangle, where they are buried by glacial drift. Where exposed in the LaSalle area they show a considerable change in the character of the Pennsylvanian sedimentation from that recorded in the rocks exposed in the Marseilles-Ottawa-Streator area. They consist mostly of limestones and calcareous shales, the basal sandstones and unconformities are lacking, and the coals are rarely more than a few inches thick. The deposits are predominantly marine with comparatively brief withdrawals of the sea at the times of underclay and coal formation.

## PERMIAN PERIOD

In the Marseilles-Ottawa-Streator area there are only a few local and thin deposits between those of the Pennsylvanian and the Pleistocene periods, an interval which consists of the Permian period of the Paleozoic era, all of the Mesozoic era (Triassic, Jurassic, and Cretaceous periods), and the Eocene, Miocene, and Pliocene periods of the Cenozoic era. The geologic history of the area during that long interval, except for the later folding of the LaSalle anticline and subsequent erosion, must be inferred from events known to have occurred elsewhere on the North American continent.

The existence of marine and nonmarine Permian beds similar to the Pennsylvanian beds and succeeding them without any significant break both in eastern and southwestern United States suggests that they may have been also deposited and subsequently eroded in the Marseilles-Ottawa-Streator area, although it is also possible that the area lay slightly above the sea and that erosion was the dominant process.

The change from marine to nonmarine sediments late in the Permian period reflects an emergence that culminated in the folding and uplift of the Appalachian Mountains. At the same time, probably affected by the enormous earth forces that formed the Appalachian Mountains, other structural features in North America were formed or suffered additional movements, and it seems reasonable to suppose that at this time occurred the last recognizable folding of the LaSalle anticline although the lack of younger deposits prevents exact determination of its age. This interval of intense diastrophism terminated the Paleozoic era.

## MESOZOIC ERA

During all the fifty million or more years comprising the Mesozoic era, while many thousands of feet of deposits accumulated in the western part of the continent where the sea repeatedly invaded the area now occupied by the Rocky Mountains, the Marseilles-Ottawa-Streator area is believed to have been a land area lying at no great height above the sea-level. However, during the Cretaceous period, in one of the most extensive floodings of the continent of all times, the western seas extended eastward at least as far as west-central Iowa and those from the Gulf of Mexico reached north at least as far as the southern end of Illinois, and the sea may have extended to this area.

Although erosion was dominant in the Marseilles-Ottawa-Streator area throughout the Mesozoic era, continental deposits and soils probably accumulated at least temporarily in favorable localities. Near the close of the era, when volcanic activity was widespread in the western part of the continent and great thicknesses of volcanic ash accumulated, it is highly probable that volcanic ash was carried into this area by westerly winds, because layers of bentonite, a clay formed by alteration of volcanic ash, have been found in late Cretaceous deposits in the Tennessee Valley. As no evidence of volcanic activity at this time has been found in the eastern part of the continent, the ash was probably derived from the western volcanoes.

Several cycles of erosion may have occurred in the Marseilles-Ottawa-Streator area during the Mesozoic era, as fluctuations of the interior seas indicate many changes of base-levels of erosion. There is no reason to believe the area ever stood at any great height above the sea, and consequently it is improbable that erosion ever produced any mountainous relief in the area, but during the mature stage of erosion the local relief may have mounted to the equivalent of the several hundred feet of Paleozoic formations eroded over the LaSalle anticline.

Reptiles were so dominant in the animal life of the Mesozoic era that it is known as the "Age of Reptiles," and it may be safely assumed that some of the many gigantic and bizarre dinosaurs roamed over the area, reptilian birds flew through the air above it, and other large reptiles inhabited the neighboring seas.

A luxuriant vegetation similar to that known to have been present in the western part of the continent during Mesozoic time probably covered the Marseilles-Ottawa-Streator area at least part of the time. The forests were dominated by spore-bearing plants and gymnosperms. The modern flowering plants (angiosperms) developed late in the era, and with their rise a great variety of insects also developed.

At the end of the Mesozoic era the Rocky Mountains were folded and the Appalachian Mountains were again uplifted. The complete withdrawal of the seas from the continent indicates a general uplift, in which the Marseilles-Ottawa-Streator area was included.

## CENOZOIC ERA

The Cenozoic era, which includes present time, is thought to have started 20 to 40 million years ago and to comprise about 4 per cent of geologic time.

## TERTIARY PERIODS

While thick Tertiary deposits were laid down in seas that invaded the margins of the North American continent and in early Tertiary time extended up the Mississippi Valley embayment at least as far as southern Illinois, while great thicknesses of continental deposits accumulated in the mountain areas of the west, while the Sierra Nevada and Coast Range mountains were folded and uplifted along the west coast with volcanoes active from Alaska to Panama, erosion continued in the Middle West throughout most of Tertiary time, as it had throughout most of Mesozoic time. It is impossible to determine the erosion accomplished respectively in Mesozoic and in Tertiary times, but altogether it removed from the Marseilles area all contemporaneous and Permian deposits that may have been deposited, at least 500 feet of Pennsylvanian strata, and probably 150 feet of St. Peter sandstone. By latest Tertiary or early Pleistocene time, the area was reduced to a peneplain, an almost plain surface of low relief with some gently sloping hills as much as 50 feet high. The peneplain truncates the LaSalle anticline and all the formations from the Shakopee dolomite to the youngest Pennsylvanian beds within less than two miles, and in spite of their striking differences in resistance to erosion the peneplain retains its fairly flat surface.

This peneplain surface is doubtless continuous with the one recognized in the Dixon-Kings-Oregon area[3], as the two

[3]Bretz, J Harlen, Geology and mineral resources of the Kings quadrangle: Illinois Geol. Survey Bull. 43, pp. 273-277, 1923.

Knappen, R. S., Geology and mineral resources of the Dixon quadrangle: Illinois Geol. Survey Bull. 49, pp. 90-92, 1926.

Bevan, Arthur, Geology and mineral resources of the Oregon quadrangle: Illinois Geol. Survey, unpublished manuscript.

areas approach to within 22 miles of each other, and it is hardly conceivable that two such surfaces of advanced erosion could be developed at different levels so near one to another. In the north part of the Oregon quadrangle the peneplain has an elevation of 900 feet, or 300 feet higher than in the Ottawa quadrangle, so that it has an average southerly slope of 4-5 feet per mile for the 60-70 miles intervening.

Erosional surfaces in the unglaciated area in northwestern Illinois and southwestern Wisconsin have been variously described as the result simply of differential erosion,[4] or of one or two periods of peneplanation subsequently modified by rejuvenated erosion.[5] The most recent discussion of the problem further demonstrates that the highest upland surfaces are broad remnants of a peneplain that slopes from an altitude of more than 1400 feet near Sparta and Tomah, Wisconsin, to about 900 feet in northwestern Illinois[6], a difference of more than 500 feet in about 100 miles, or a slope of about 5 feet per mile. The slope and elevation of this peneplain, which had been earlier recognized and named Dodgeville[7], identifies it with the one recognized in the Dixon-Kings-Oregon and the Marseilles-Ottawa-Streator areas.

Following the erosion of the Dodgeville peneplain, rejuvenation increased the energy of the streams and they transported sand and gravel into the area. The limited deposits of Late Tertiary gravels in this area provide little information as to the source of the sediments and the conditions of deposition. It has been suggested that similar deposits in Wisconsin[8] were deposited by streams with strong velocity in a region of considerable relief. The deposits were probably confined to the courses of the streams and were not part of a continuous sheet.

[4]Martin, Lawrence, Physical geography of Wisconsin: Wisconsin Geol. and Nat. Hist. Survey Bull. 36, 2nd ed., 1932.

[5]Trowbridge, A. C., The erosional history of the Driftless area: Univ. of Iowa Studies in Nat. Hist., vol. 9, No. 3, 1921.
Thwaites, F. T., in Guidebook Ninth Annual Field Conference, Kansas Geol. Soc., p. 120, 1935.
Bates, R. E., Geomorphic history of the Kickapoo region, Wis.: Geol. Soc. America Bull., vol. 50, pp. 819-880, 1939.

[6]Bates, R. E., op. cit., p. 824.

[7]Trowbridge, A. C., op. cit., p. 64.

[8]Thwaites, F. T., and Twenhofel, W. H., Windrow formation, an upland gravel formation of the Driftless area and adjacent areas of the Upper Mississippi Valley: Geol. Soc. America Bull., vol. 32, p. 311, 1921.

The presence of quartz pebbles and other rocks foreign to the local area is evidence that the streams which deposited the gravel must have had their source far from the area. They also must have been part of a drainage system radically different from and much older than River Ticona, which later dissected the peneplain. This dissection occurred late in Tertiary time or in Pleistocene time before Kansan glaciation.

The base-level that had determined the erosion of the area to a peneplain was lowered, so that the streams were rejuvenated and incised deep channels in the bedrock. The deep valley of River Ticona was eroded in the bedrock surface directly across the LaSalle anticline and probably marks the position of one of the larger streams which flowed on the peneplain before uplift occurred (fig. 88). The presence of Kansan deposits in the bedrock valleys, especially in the area west of LaSalle, indicates that dissection of the peneplain was accomplished before Kansan time. From evidence in other areas it has been suggested[9] that deep erosion did not occur until after Nebraskan glaciation.

## PLEISTOCENE PERIOD

The beginning of the Pleistocene or "Glacial" period was marked by a worldwide change of climate which resulted in extensive continental glaciation in the northern hemisphere and in extensive mountain glaciation in both the northern and southern hemispheres. Alternating changes of climate during the period resulted in at least four such glacial stages with prolonged intervening interglacial stages when the climate was essentially the same as at present. During each glacial stage large areas of North America (fig. 103) were covered by a broad monotonous expanse of snow and ice, probably appearing much like that covering Greenland or Antarctica at present. The Marseilles-Ottawa-Streator area lies within the glaciated area.

*Evidence of glaciation.*—The conception of continental glaciation is now universally recognized and accepted, although less than a hundred years ago the origin

[9]Trowbridge, A. C., op. cit., p. 126.


Fig. 103.—Map of North America showing the maximum extent of the Pleistocene glaciers.

of the glacial deposits was a moot question. The widespread distribution of glacial drift over hill and dale, its heterogeneity of composition, the presence of fragments of igneous and metamorphic rocks derived from localities hundreds of miles away, the abundance of striated and faceted pebbles, the smooth and rounded contours of rock prominences, the presence of rock-gouged basins, the irregular surface and systematic pattern of the moraines, and the similarity of these features with those of deposits formed by modern glaciers have convinced all of their glacial origin.

*Cause of glaciation.*—The fundamental cause of glaciation is one of the great unsolved problems of geology. Shifting of the axis of the earth, sun-spots affecting climates, extraction of part of the carbon dioxide from the air, passage of the solar system through a "cosmic cloud" which partly absorbed the sun's radiation, cyclic changes in solar radiation, and elevation of the continents have been suggested as possible causes, but none of them taken alone has proved satisfactory in all respects.

It is not in keeping with the purposes of this report to delve further into this question, but it seems probable that glaciation was caused by an unusual combination of factors rather than by any single cause. Whatever the cause, the result was that over a long period of time, measured in thousands of years, more ice and snow accumulated each cold season than melted in the following warm season, culminating in extensive ice-sheets.

*Movement of the glaciers.*—When the ice accumulated to such a thickness that its weight and internal stresses overcame its internal resistance it began to spread slowly outward in all directions, and this movement continued so long as accumulation of snow maintained these conditions. As the ice advanced southward from fields of accumulation in Canada, it invaded areas of warmer climate, and the front of the glacier eventually reached a position where each year melting equalled the forward advance of the ice. The front of the glacier receded when a climatic change either increased the rate of melting or decreased the amount of snowfall.

Studies of existing glaciers show that their movement is very slow, usually not more than a few feet per day, and because of melting the rate of advance of the ice-front is even less. If an average yearly advance of one foot per day were maintained, the rate of advance would be about one mile in 15 years.

The rate of retreat of the last continental glacier, the Wisconsin, has been measured by counting annual layers of clay and silt deposited in lakes at the front of the glacier and varies from one mile in 2¼ years over one stretch of 745 miles, to one mile in 21 years over another stretch of 185 miles.[10]

*Thickness of the ice.*—That the Pleistocene glaciers were very thick is indicated by their depression of a large area of the earth's crust several hundred feet, by their ability to override and scour many high elevations and to advance out of and beyond great depressions like the basins of the Great Lakes, and by the great amount of material and the large size of some erratic boulders which they transported. The present Greenland glacier has an average thickness of about 3,000 feet with thicknesses locally nearly two miles,

[10]Antevs, Ernst, The last glaciation, with special reference to the ice retreat in northeastern North America: Am. Geog. Soc., Research Ser. No. 17, 1928.

but the Pleistocene ice-sheet over southern Canada was probably much thicker. As determined by the height of the elevations it covered in New England, it must have been at least 6,000 feet thick along the axis of St. Lawrence Valley. The thickness of the ice in the accumulation centers has been estimated at 10,000 feet,[11] and over the Marseilles-Ottawa-Streator area it was at times probably several thousand feet thick.

*Centers of accumulation.*—Studies of the distribution of glacial deposits and of striations on the bedrock indicate that the principal Pleistocene glaciers which affected North America advanced from three major centers of accumulation—the Labradorean east of Hudson Bay, the Keewatin west of Hudson Bay, and the Cordilleran in the western mountains—and also in some of the late stages from a minor center, the Patrician, south of Hudson Bay. The Marseilles-Ottawa-Streator area was covered by ice from the Labradorean and possibly Patrician centers. During the warmer interglacial stages these centers of accumulation were doubtless entirely free from glacial ice.

*Glacial climate.*—Each of the four glacial stages and the succeeding interglacial or postglacial stage, and the consequent advances and retreats of the ice which detailed studies of the glacial deposits have revealed, constitute a major climatic cycle[12] (p. 147). There is increasing indication that each of the glacial stages comprises two or more substages or intermediate climatic cycles. Based on the distribution of the moraines of the last or Wisconsin glacial stage in North America, it is generally divided into four substages, and a possible fifth substage is recognized by some geologists. The moraines of the Illinoian stage in Illinois indicate it consists of at least two, possibly more, substages. In Europe the stages thought to be equivalent to the Kansan and Nebraskan of North America each consist of two substages. The divisions into substages is also supported by astronomical theories based on variations in solar radiation which call for multiple "cold stages" with intervening interstadial periods of ameliorated climate in each glacial stage.[13]

In addition to the major and intermediate climatic cycles, many lesser variations of climate caused repeated advances and retreats of the ice-front during each of the glacial stages. These are best shown by the moraines of the Wisconsin stage as the earlier ones have been overridden extensively by later glaciers and are more modified by stream erosion. Behind the moraine formed at the maximum advance of each substage of the Wisconsin glacier are many other roughly concentric moraines, some of which may be truly recessional moraines formed at temporary halts in the retreat of the ice-front, but most of them record some readvance after a retreat. They reflect during each substage of deglaciation slight variations of climate repeatedly above and below the point where melting and rate of advance of ice-front were balanced, the interval of excess melting being somewhat longer or more intense. It is reasonable to think that similar climatic variations occurred before the ice reached its maximum advance, with the interval of ice-advance greater than that of predominate melting, but any moraines that were deposited during the advance of the ice-front are rarely identifiable. The irregular size and distribution of the moraines made during the retreat of the ice-front suggest that the climatic variations were not uniformly rhythmical, although many of the irregularities may be the result of local influences, such as topography, unequal ice melting, or of variations in the load of the glaciers. Although the length of these climatic variations is not evident from the deposits, it is believed that they are to be measured in terms of thousands of years.

It is probable that similar climatic variations occurred during the interglacial stages but the preservation of the fauna or flora or other evidence is insufficient to reconstruct as complete a record as for the glacial stages.

*Length of Pleistocene period.*—Estimates of the length of the Pleistocene period, or parts of the period, have been based on the number of annual layers or varves in lake deposits, the depth of leaching, the

[11] Daly, R. A., The changing world of the Ice Age: Yale University Press, p. 34, 1934.

[12] Kay, G. F., Classification and duration of the Pleistocene period: Geol. Soc. America Bull., vol. 42, pp. 445-448, 1931.

[13] Zeuner, F. E., Pleistocene chronology of central Europe: Geol. Mag. vol. 72, pp. 350-376, 1935.

Table 9.—Length of the Pleistocene Period

| *Based on solar radiation curve*[a] | | *Based on depth of leaching in Iowa*[b] | | | *Based principally on varves*[c] | | |
|---|---|---|---|---|---|---|---|
| In Europe | Years since maximum ice advance | In North America | Minimum years since maximum ice advance | Length of stage in years | In North America | In N. Germany-Sweden | Years since Maximum ice advance (to 1900) |
| | | Post Late Wisconsin | | 25,000 | Beginning of Post-glacial | Beginning of Post-glacial | 8,700 |
| Würm 3 | 18,000 | Late Wisconsin | 26,500 | 3,000 | | W-4 Fennoscandian | 10,400 |
| Würm 2 | 67,000 | | | 27,000 | Mankato | W-3 Pomeranian | 25,000 |
| Würm 1 | 112,000 | Iowan | 56,500 | 3,000 | Tazewell-Cary | W-2 Brandenburg | 35,000 |
| Pre-Würm | 143,000 | | | | Iowan | W-1 Warthe | 65,000 |
| | | Sangamon | | 120,000 | | | |
| Riss 2 | 183,000 | | | | | | |
| | | Illinoian | 182,500 | 9,000 | | | |
| Riss 1 | 226,000 | | | | | | |
| | | Yarmouth | | 300,000 | | | |
| Mindel 2 | 430,000 | | | | | | |
| | | Kansan | 490,750 | 7,500 | | | |
| Mindel 1 | 472,000 | | | | | | |
| | | Aftonian | | 200,000 | | | |
| Günz 2 | 545,000 | | | | | | |
| | | Nebraskan | 698,250 | 7,500 | | | |
| Günz 1 | 586,000 | | | | | | |
| Three Pre-Günz | 680,000- | | Total | 702,000 | | | |
| Cold Stages | 760,000 | | | | | | |
| Gravel terrace | 840,000 | | | | | | |
| Gravel terrace | 930,000 | | | | | | |

[a]Zeuner, F. E., Pleistocene chronology of central Europe, Geol. Mag., vol. 72, table facing p. 357, 1935.

[b]Kay, G. F., Classification and duration of the Pleistocene period, Geol. Soc. America Bull., vol. 42, pp. 460-461, 1931.

[c]Bryan, Kirk, and Ray, L. L., Geologic antiquity of the Lindenmeier site in Colorado, Smithsonian Miscel. col., vol. 99, No. 2, pub. 3554, p. 67, 1940.

extent of erosion, the retreat of waterfalls, and solar radiation curves. The correlation of the glacial stages recognized in Europe with intervals of increased and decreased solar radiation calculated on the periodical alternations of some elements of the orbit of the earth shows a remarkable agreement and, if the curve of solar radiation is correct, closely dates many events during the Ice Age (table 9). The minimum length of Pleistocene time in Iowa has been calculated from estimates of the length of both the interglacial and glacial epochs (table 9). The length of the interglacial epochs was determined from the thickness of the leached zone on the upland gravel deposits, assuming that post-Mankato time in Iowa is 25,000 years during which 2½ feet of gravel was leached. The length of time the glaciers covered Iowa was determined on the basis of an estimated average advance and retreat of the ice at one mile in ten years. These data were interpreted as indicating that the entire length of the Pleistocene period was probably one million years and it may have lasted twice as long. A recent consideration of the length of the Wisconsin stage based principally on varves, and also the data on the depth of leaching, indicate that the stage was only about half as long as suggested by the curve of solar radiation (table 9).

*Pleistocene life.*—The life of the Pleistocene period[14] was much like that of the present day, although a number of conspicuous forms, such as the mastodon, mammoth, sabre-toothed tiger, cave bear, giant sloth, dire-wolf, and giant beaver, became extinct, and numerous others, such as the deer, elk, wild horse, camel, bison, and musk-ox, had a range greatly different from that of Recent time. Although no remains of Pleistocene vertebrates are known to have been found in the Marseilles-Ottawa-Streator area, it is significant that some have been uncovered in nearby areas, usually in swamps where the animals were trapped, and it is to be inferred that all of these animals were residents of the area.

Both air-breathing and aquatic invertebrates lived in the area during the interglacial stages and some of them during the glacial stages when the area was free from ice. Some of the animals as well as some plants lived at no great distance from the ice-front, as shells of aquatic invertebrates have been found in the LaSalle area in Lake Illinois deltal beds that are known to have been deposited near the ice-front, and shells of air-breathing forest-inhabiting invertebrates have been found in the loess deposits, the accumulation of which took place when the ice-front was not far away.

The Pleistocene plants probably lived in climatic zones around the ice-front similar to those found at present between arctic and tropical latitudes or between low and high altitudes in mountainous areas, and the zones migrated with the advance and retreat of the ice. Studies of pollen in bog deposits on the Wisconsin drift indicate the earliest flora were dominated by the conifers which gradually declined with advance of the deciduous forests.[15]

Although it has long been known that man lived in Europe throughout most of the Pleistocene period, it was not until the last few years that evidence of his existence in North America in the early Recent and possibly before the Recent has been found. However, the distribution of this evidence in Minnesota,[16] Colorado,[17] and Texas,[18] as well as elsewhere, indicates that he probably ranged widely over the continent.

## GRANDIAN EPOCH

### Nebraskan Age

Although the Nebraskan glacier may have covered the Marseilles-Ottawa-Streator area, there is no evidence of it,

[14]Baker, F. C., The life of the Pleistocene or Glacial period: Univ. Illinois Bull., vol. 17, No. 41, 1920.

Hay, O. P., The Pleistocene of the Middle Region of North America and its vertebrated animals: Carnegie Institution of Washington, Publication 322A, 1924.

[15]Voss, John, Comparative study of bogs on Cary and Tazewell drift (Abst.): Illinois Acad. Sci. Trans., vol. 29, No. 2, p. 81, 1936.

[16]Jenks, A. E., Pleistocene man in Minnesota: Univ. of Minn. Press, 1936.

[17]Bryan, Kirk, and Ray, L. L., Geologic antiquity of the Lindenmeier site in Colorado: Smithsonian Misc. coll., vol. 99, No. 2, 1940.

[18]Sellards, E. H., Artifacts associated with fossil elephant: Geol. Soc. America Bull., vol. 49, pp. 999-1010, 1938.

and it is believed that the erosion that had dominated the area so long during the Mesozoic and Cenozoic eras continued without interruption. The rejuvenation of the streams that followed the development and uplift of the Dodgeville peneplain may have begun not later than the Nebraskan age.

### Aftonian Age

The Aftonian interglacial age was marked by extensive erosion and weathering of the Nebraskan drift and of the bedrock in the unglaciated areas. A thick gumbotil was formed on the Nebraskan drift in the flat poorly drained interstream areas, and locally deposits of silt and peat were formed. If the uplift of the Dodgeville peneplain and consequent rejuvenation had not begun previously, it must have started or continued during the Aftonian age, as the incised valleys contain drift of Kansan age. River Ticona and its tributaries were entrenched deeply in the Dodgeville peneplain.

## OTTUMWAN EPOCH

### Kansan Age

The Kansan glaciers from both the Labradorean and Keewatin centers invaded respectively the eastern and western parts of Illinois, and from the distribution of the Kansan drift it appears that the Marseilles-Ottawa-Streator area was covered entirely by the Labradorean ice moving over the area from the east or northeast. All of the soil and weathered material, which may have had considerable thickness below the flat areas of the Dodgeville peneplain, was completely removed and some of the bedrock was eroded because, as the glacier receded, it left its drift directly on unweathered rock.

### Yarmouth Age

The Yarmouth was the longest of the interglacial ages, so much longer, in fact, that it may justify a bipartition of the Pleistocene period, each group consisting of two glacial ages and an interglacial age. Two and possibly three parts of the Yarmouth age are recognizable. During the earliest part long-continued weathering produced on the Kansan drift a gumbotil that has a maximum thickness of 15 feet and an average thickness of about 11 feet, with a corresponding depth of leaching below. Forests throve, and deposits of peat and soil accumulated, of which good exposures occur a short distance west of this area.[19] During the later part of the age a widespread loess accumulated over the gumbotil and soil, and still later both loess and drift were deeply eroded.

## CENTRALIAN EPOCH

### Illinoian Age

The Illinoian glacier advanced from the Labradorean center southward nearly to the southern end of Illinois and westward to and locally a short distance beyond Mississippi River. This was the most extensive advance of any glacier from the Labradorean center and at its maximum reached farther south than any other Pleistocene ice-sheet. There is no record of an Illinoian glacier from the Keewatin center.

In the Marseilles-Ottawa-Streator area the Illinoian glacier scoured down to bedrock, generally removed all or most of the Kansan drift except in the preglacial channels, and incorporated within its drift all of this material as well as broken fragments of wood from the extensive forests it overrode and destroyed. The drift that the glacier deposited when it melted probably almost filled all of the bedrock channels except that of River Ticona, which carried much of the melt-water from the ice, as is shown near Seneca where the top of the Illinois drift in Ticona Valley is below the top of the bedrock in the surrounding area.

### Sangamon Age

Although the Sangamon age was shorter than either the Aftonian or Yarmouth interglacial ages it was many times longer than the Recent and consists of at least two and possibly three parts. During the earliest part long-continued weathering developed 2 to 5 feet of gumbotil on the Illinois drift in favorable areas and leached a corresponding amount of drift below. Organic matter accumulated and locally peat was formed in depressions on the

[19]Cady, G. H., Geology and mineral resources of the Hennepin and LaSalle quadrangles: Illinois Geol. Survey Bull. 37, pp. 71-72, 1919.

drift. In the Marseilles-Ottawa-Streator area gumbotil is generally lacking but as much as 5 feet of noncalcareous till locally occurs at the top of the Illinoian. A few small lenses of thoroughly decomposed till, probably gumbotil, were found in slumped deposits of Sangamon age, but the gumbotil and most of the leached zone were eroded before the Wisconsin deposits were laid down.

During the later part of the Sangamon age a loess was deposited over the Early Sangamon soil. This loess was generally eroded from the Marseilles-Ottawa-Streator area by the advancing Wisconsin glaciers but is found at many localities west and south. In areas where the Sangamon deposits are well exposed the Late Sangamon loess is overlain by soil and peaty material which show a youthful profile of weathering. It is therefore apparent that the Sangamon age is comprised of a long period of weathering, an interval of loess accumulation, and then another but much shorter period of weathering.

## ELDORAN EPOCH

### Wisconsin Age

The Wisconsin ice-sheet extended farther south in New England and in the western Great Plains than did the earlier ice-sheets, but in the Middle West the Wisconsin glaciers did not extend as far south as the earlier ones. They advanced from the Keewatin, Labradorean, and Patrician centers not simultaneously but successively so that the later ones irregularly overrode some of the moraines formed by the earlier ones. Because of this shifting of the ice-front and the probability that important retreats preceded the shifts, the Wisconsin age has been subdivided into four intervals, namely the Iowan, or earliest, during which the ice advanced from the Keewatin center; the Tazewell, with a glacier mainly from the Labradorean center; the Cary, with a glacier mainly from the Patrician center; and the Mankato, with a glacier again mainly from the Keewatin center.

The Wisconsin glaciation occurred so recently geologically that only a relatively thin and youthful soil profile has been developed on its drift and the topography of the drift has been little modified except by erosion along the major valleys, as compared with the deep mature soil profiles, thick gumbotils, and advanced erosional effects developed on each of the older drifts during the long interglacial ages. Although the difference in degree of dissection of the topography is generally distinct between the Illinoian and the earliest Wisconsin drift in Illinois, the later Wisconsin drift also is notably fresher than the earlier Wisconsin deposits and has a greater abundance of undrained depressions. Whereas lakes and swamps are abundant on the Cary drift, they occur only occasionally on the Tazewell and especially the early Tazewell drift.

#### IOWAN SUB-AGE

The Iowan glacier advancing from the Keewatin center reached Clinton, Iowa, but apparently did not invade Illinois. However, loess accumulated extensively in Illinois as well as in Iowa and elsewhere. The Iowan loess was eroded from the Marseilles-Ottawa-Streator area by later Wisconsin glaciers, but it is found below Tazewell drift in areas west and south, and outside the area of Tazewell drift it comprises the lower part of the thick Peorian loess.

#### TAZEWELL SUB-AGE

The Tazewell glacier advanced from the Labradorean center and moved westerly or southwesterly across the Marseilles-Ottawa-Streator area to its most advanced position at Geneseo and Peoria (fig. 90). Several of the successive partial retreats and readvances of the Tazewell glacier transgressed the area, and all the moraines in the area were formed during the latter part of Tazewell time.

*Shelbyville glaciation*

The advancing Shelbyville glacier, the first of the Tazewell, probably eroded the earlier glacial deposits intensively. During its advance, at least 30 feet of sand and gravel outwash was deposited in the preexisting valleys, either in front of or beneath the ice. At its maximum position the glacier built the Shelbyville moraine along its front and as it retreated it deposited a sheet of ground-moraine. This till-sheet was too thin to fill the large valleys, so that they remained as depressions in the drift surface.

*Lake Kickapoo.*—Where the Shelbyville moraine had been built across Illinois Valley at Peoria it served as a dam behind which, as the ice receded, the melt-waters accumulated to form Lake Kickapoo, which extended up Ticona Valley and its principal tributary valleys. The sand and silt deposited in the lake is found up to an elevation of 600 feet so that the level of the lake must have been at least that high. The level of the lake was determined by the elevation of its outlet, which was probably where the moraine crossed Illinois Valley, as that would be the lowest point along the moraine. It is doubtful if the maximum elevation was long maintained, as most of the lake deposits occur below an elevation of 575 feet. The laminations in the lake silts suggest varves resulting from seasonal variations in the amount of melting and consequent variations in the amount of material carried by melt-waters into the lake.

Lake Kickapoo existed until the ice had retreated at least as far as the north part of the Marseilles quadrangle. It appears to have been drained before Bloomington glaciation, as the deposits of the advancing Bloomington ice which overlie the lake beds have the structure of stream deposits.

The presence of fossil wood in the Lake Kickapoo deposits is evidence that trees were growing near the lake.

### *Leroy, Cerro Gordo, and Champaign Glaciations*

As shown by the relations of the Shelbyville, Leroy, Cerro Gordo, Champaign, and Bloomington moraines in central Illinois (fig. 90), the ice-front of the early Tazewell glacier retreated and readvanced at least three and possibly four times between its positions at the Shelbyville and Bloomington moraines. However, the recognition of only one pre-Bloomington drift of Tazewell age in the Marseilles-Ottawa-Streator area indicates that there was only one retreat of the ice-front across the area prior to the Bloomington readvance. The exact time of this retreat has not been determined. The alignment of the moraines suggests that the Leroy glacier covered the area and that the Champaign glacier did not, and if true, the retreat across the area occurred after the Leroy readvance, and the pre-Bloomington Tazewell till in the area is therefore Leroy in age. However, the Leroy glacier may not have covered the area and, as it is certain that the Shelbyville ice did, the till, like the outwash deposits beneath it, is therefore considered as Shelbyville.

### *Bloomington and Normal Glaciations*

As the Bloomington ice advanced, gravel and sand outwash was deposited in front of the ice at many places. Probably much of the outwash was again picked up by the ice as it overrode the deposits, but sand and gravel is commonly found above the deposits of Lake Kickapoo and below the pink Bloomington till. The Bloomington ice probably did not erode the earlier deposits to any great depth, or the underlying lake beds would not be preserved so commonly, but it did erode all the earlier glacial deposits in some areas so that Bloomington deposits locally rest directly on bedrock (fig. 86).

At its maximum advance the Bloomington ice-front was comparatively stationary or fluctuated across a narrow zone for a considerable period of time, as the Bloomington moraine is one of the largest of the Wisconsin moraines. After a retreat from the Bloomington moraine the ice-front readvanced and deposited the Normal moraine. They are usually considered as a single drift designated as Bloomington. The pink color of both the Bloomington and Normal drifts in contrast to the predominately gray color of earlier and later drifts reveals that the two ice-sheets had the same gathering ground.

When the Bloomington ice melted away it left a widespread mantle of pink till. Most of the earlier glacial deposits in the Marseilles-Ottawa-Streator area are preserved chiefly in depressions in the bedrock surface but the Bloomington till covers all the area except where it was locally eroded by later glaciers or glacial rivers.

*Lake Illinois.*—At its maximum position the Bloomington ice-front crossed Illinois Valley at Peoria, deposited its moraine on top of the Shelbyville moraine, and built a long, gently sloping valley-train down the valley in front of the moraine. The moraine and valley-train made a dam across Illinois Valley behind which Lake Illinois formed as the ice-front receded. The lowest sag in the moraine was at an elevation of about 600 feet above sea-level, as delta deposits made in the lake show that it maintained a level at an elevation of about 600 feet throughout the Bloomington-Normal, Cropsey, Farm Ridge, and Chatsworth glaciations, and it was not until late in the Marseilles glaciation that the dam was breached and the lake drained. This level was maintained despite the large volumes of glacial and normal drainage water that must have flowed over the dam, probably because the lake water carried no materials to give it great erosive power and also possibly because the broad moraine became studded with boulders concentrated by the first erosion of the till.

Lake Illinois probably had its maximum extent and volume during the retreat of the Bloomington glacier, as the ice apparently receded farther at that time than after any of the succeeding glaciations, and also because the later glaciers not only considerably reduced the area of the lake but raised its bottom by deposition of successive sheets of drift.

Extensive deposits accumulated in Lake Illinois during the retreat of the Bloomington-Normal glacier. In some areas deltas were built into the lake near the ice-front at the mouths of glacial streams, but none have been found in the Marseilles-Ottawa-Streator area, where the lake deposits consist largely of laminated silts and clay with some beds of sand and locally a little gravel.

The recession of the Bloomington glacier appears to have been one of the major recessions of Tazewell time, although it is not known how far the ice-front retreated. Deposits believed to be related to Lake Illinois and also the presence of pink till near Joliet[20] indicate the Bloomington glacier receded at least to that point.

[20]Fisher, D. J., Geology and mineral resources of the Joliet quadrangle: Illinois Geol. Survey Bull. 51, pp. 75-76, 1925.

### *Cropsey Glaciation*

When the ice readvanced in Cropsey time the area of Lake Illinois was greatly reduced as it was invaded by the ice. Locally gravel and sand was deposited over the lake silts and then overridden by the advancing ice. The lake deposits were eroded by the advancing ice at only a few places and the almost universal presence of the pink Bloomington-Normal till beneath Cropsey drift in the Streator area indicates that there at least the Cropsey glacier eroded much less than did the earlier glaciers.

The Cropsey glacier completely covered the Marseilles-Ottawa-Streator area and its front advanced to a position close and roughly parallel to the Normal moraine. The ice-front retreated irregularly and intermittently, so that in addition to the terminal moraine which it built at its maximum position, it built two other recessional moraines. These are known respectively as Outer, Middle, and Inner Cropsey moraines, the last of which lies along the west side of the Streator quadrangle with its crest a short distance west of the quadrangle. The moraines are usually closely parallel and not sharply differentiated from the intervening ground-moraine, and at several places they merge into a composite ridge of complex character. Moreover, each of the moraines not uncommonly consists of several ridges each of which represents a temporary stand of the ice-front after a short recession. The till deposited by the Cropsey ice was largely gray, differentiating it in this part of the State from the pink Bloomington till.

*Lake Ancona.*—When the Cropsey ice-front retreated, the melt-waters accumulated between the ice and the Inner Cropsey moraine to form the first stage of Lake Ancona in a small area in the southwest part of the Streator quadrangle. Deposits of lacustrine sand in this small area occur up to an elevation of 660 feet, which is above the level of the later lakes which inundated much of the Streator quadrangle. The lake had an outlet westward to one branch of Sandy Creek, following a subglacial channel at a reentrant in the front of the Inner Cropsey glacier (pl. 3). Sufficient water passed through the main

*Photograph by Illinois Agricultural Conservation Committee*

Fig. 104.—Aerial photograph of an area near the southwest corner of the Streator quadrangle showing by a band of uniformly dark soil the position of the outlet channel of Lake Ancona crossing the mottled soil-pattern of the Cropsey moraine. The cross-roads near the center of the photograph is at the Osage Center School at the SE. corner sec. 16, T. 30 N., R. 2 E. (Osage Twp.), Streator quadrangle. Scale, about 3 inches per mile.

outlet-valley to cut it down 10 or 15 feet and to extend it headward four miles east of the crest of the Cropsey moraine. The outlet channel is plainly discernible on aerial photographs (fig. 104), largely because in it the soils are uniformly dark in contrast to the mottled soils characteristic of the adjacent morainic areas. At the beginning of the lake some water may have flowed through another broad subglacial channel about a mile to the north.

The limited channel which the outlet stream eroded in the soft glacial materials is evidence that the high stage of Lake Ancona did not last long. The receding glacier soon uncovered a lower outlet for the lake farther north, perhaps near the present valley of Vermilion River, and the level of the lake dropped to an elevation between 640 and 650 feet. Deposits made in it at this lower stage occur as high as 640 feet and if it had been more than 650 feet it would have flowed through the Sandy Creek outlet. This level was about 40 feet higher than that of Lake Illinois, which was present outside the Cropsey moraine. The lake persisted at the lower level while the ice-front retreated at least as far as the Chatsworth moraine, a distance of about eight miles. At various stages in the retreat, streams issuing from the ice built gravel deltas into the lake.

*Post-Lake Ancona.*—The ice-front retreated an unknown distance from the Cropsey moraines before it readvanced to form the Farm Ridge moraine. On the one hand, the difference in alignment of the moraines suggests that the retreat was of considerable magnitude; on the other, the absence of any Lake Illinois deposits between the Cropsey and Farm Ridge tills where they might be expected or any other differentiation of them suggests that the retreat was not great.

With the retreat of the Cropsey glacier, drainage was established along the line of the present Illinois Valley east of Hennepin. Throughout the earlier glacial stages and the Shelbyville glaciation of the Wisconsin stage whatever drainage system existed in the Marseilles-Ottawa-Streator and adjacent areas east of the LaSalle anticline apparently followed in general that of the preglacial River Ticona, and if there was any drainage along the present Illinois Valley it existed solely as east-west tributaries of north-south tributaries of the glacial successors of the River Ticona. Why the principal drainage line should have developed along the present Illinois Valley where it had to cut across preglacial rock divides, instead of following the preglacial Ticona Valley where it had only to erode relatively soft glacial materials, is speculative. Normally the same or even greater thicknesses of glacial drift would have been deposited elsewhere, leaving the valley as the lowest line for drainage. But the probable explanation is that by the end of Shelbyville time Ticona Valley and its tributaries had been nearly filled with glacial outwash, lacustrine deposits, and till, which on account of their relatively low position were protected from erosion by the later glaciers. Consequently the deposits of the retreating Bloomington-Normal glacier nearly if not completely obliterated the old drainage system. At any rate the Inner Cropsey glacier deposited a moraine across Ticona Valley at Ticona without noticeable depression. Possibly subglacial drainage of the Bloomington-Normal glacier, or of the Cropsey glacier itself, left a depression which determined the position of Illinois Valley. At any rate, with the retreat of the Cropsey glacier, possibly with the retreat of the earlier Bloomington-Normal glacier, the present upper Illinois drainage system was begun.

As the Cropsey ice retreated, Lake Illinois extended into the valley, submerging it to an elevation of 600 feet. Some of the Cropsey gravel deltas that were built into the lake near Spring Valley extend down to an elevation of 550 feet, indicating that the base of drainage was at least that low and that Lake Illinois there had a depth of 50 feet or more.

### *Farm Ridge Glaciation*

Following the retreat of the Cropsey glacier, the ice readvanced and built the Farm Ridge moraine along the west side of the Ottawa quadrangle and the north side of the Streator quadrangle. Meltwater flowed from many subglacial channels and deposited gravel and sand in outwash plains, especially in the northwest part of the Ottawa quadrangle. The Covel Creek esker, a few miles south of Illinois Valley, marks the course of what was a large subglacial river in which gravel and sand was deposited and then covered with a mantle of till. The glacier overrode the east branch of the Inner Cropsey moraine and probably formed a temporary lake in Vermilion Valley, although no lacustrine deposits have been recognized.

Back of the moraine, till was deposited in a gently undulatory ground-moraine, which in the north part of the Ottawa quadrangle is crossed by shallow channels probably eroded by melt-water from the ice-front as it retreated. Boulders were concentrated and thin deposits of gravel and sand were locally formed along the channels.

*Lake Illinois.*—As the ice-front retreated Lake Illinois again inundated Illinois Valley and all the adjacent areas below an elevation of 600 feet. Large quantities of gravel, sand, and silt were carried into the lake by glacial streams and were deposited in deltas.

The deltas were formed mostly in bays that filled valleys almost at right angles to the present valley. Some of the valleys probably existed before Shelbyville time and may have been partly reexcavated after the draining of Lake Kickapoo. The deltas were formed near the ice-front, as the materials are very poorly sorted, much of the material is highly angular, some pebbles are faceted and striated, and till balls are common. The deposits also contain weathered pebbles, cobbles, and boulders of igneous and metamorphic rocks so soft they can be pulverized between the fingers, associated with unaltered limestone and dolomite, showing not only that their decomposition took place before they were picked up by the glacier and deposited in the gravel but also that they must have been frozen to withstand the transportation. The steeply dipping foreset beds, the poor assorting, the abundance of coarse gravel and cobbles and boulders, and the low content of sand all show rapid accumulation. It has been suggested[21] that in the main, each delta was deposited in a single summer season of melting. In several of the deltas the foreset beds are overlain by laminated silts which are thought to record reduced melting during the winter season. In a sense, therefore, each deposit represents a gigantic varve, the record of a single year. In the large delta south of Ottawa the silt bed is overlain by another deposit of gravel which, according to this idea, probably represents a second summer's melting. The foreset-bedding in the upper deposit is less continuous than in the lower and is interrupted by cross-bedding, which indicates shallower water as a result of filling, and the small amount of coarse materials indicates retreat of the ice-front.

At the close of Farm Ridge glaciation the ice-front retreated an unknown distance but it was at least some distance east of the Marseilles moraine, as the latter overrides the Chatsworth moraine which in turn overrides the Farm Ridge moraine.

### *Chatsworth Glaciation*

When the ice-front readvanced in Chatsworth time a lobe invaded the east side of the Streator quadrangle and reached its most westerly position near the east side of Streator. The moraine deposited at this position extends for many miles southeast but to the north it was later overridden by the Marseilles ice a short distance east of the northeast corner of the Streator quadrangle. A weakly developed moraine which diverges from the main Marseilles moraine near the north end of the Marseilles quadrangle may be the Chatsworth moraine.

From the nose of the glacial lobe near Streator a prominent subglacial river emerged and left a depression that is now occupied by the headwaters of Otter Creek. Some sand and gravel deposits along the creek which have deltal structure were possibly deposited in Lake Ancona during the retreat of the Cropsey ice, but it is also possible that the Farm Ridge moraine blocked the drainage from Vermilion Valley and formed a lake that was not drained until after the Chatsworth glaciation.

Lake Illinois still occupied Illinois Valley in Chatsworth time but it probably did not extend up Vermilion Valley as far as the Streator quadrangle. Drainage from Chatsworth ice was concentrated into Vermilion Valley and thence flowed into Lake Illinois.

At the close of Chatsworth time the ice retreated an unknown distance, possibly not much beyond the present front of the

[21]Leighton, M. M., personal communication.

Marseilles moraine, as the Marseilles and Chatsworth moraines are closely parallel for a long distance and the drifts are similar in character.

### *Marseilles Glaciation*

The ice readvanced in Marseilles time, covered most of the Marseilles quadrangle, and extended into the east part of the Ottawa quadrangle. The most advanced of the three recognizable positions of the ice-front formed a small lobe down Illinois Valley, which was then only a relatively small valley, but in the later stages the ice-front apparently extended almost directly across the valley. The large size of the Marseilles moraine indicates that the ice-front remained at this position much longer than at other Tazewell moraines in this area, although it fluctuated sufficiently to develop three crests.

From the Marseilles ice-front, water issued at closely spaced points, clearly recorded by subglacial channels and deposits of gravel and sand. The water was concentrated along the front of the moraine in a shallow channel which later became Fox Valley. South of Illinois Valley, Marseilles melt-water started the erosion of the valley of Covel Creek, and farther south, water from many miles of the ice-front passed through gaps in the Chatsworth moraine into Vermilion Valley to form a river draining into Lake Illinois. So great was the volume of subglacial water along Illinois Valley that little till accumulated in the valley. When the ice-front began to retreat, the floor of the channel was at least as low as 580 feet above sea-level, as the deltas then made in Lake Illinois extend down to that elevation. Locally small eskers and kames were formed in channels or caves in the ice.

As the ice retreated there were many depressions occupied by lakes, a few of which persisted until drained by man.

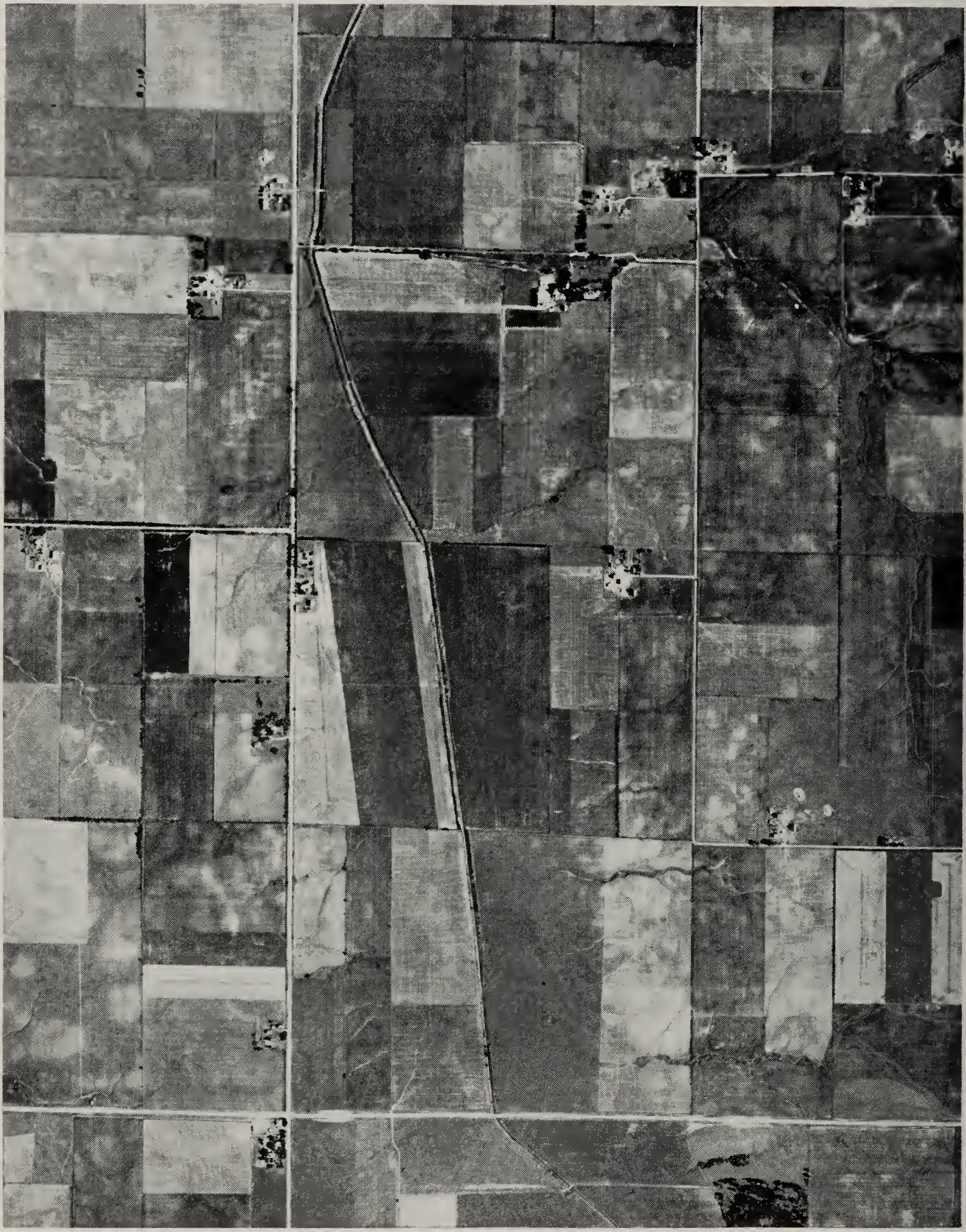
*Lake Lisbon.*—The ice-front retreated from the moraine in the northeast part of the Marseilles quadrangle while still extending up the back slope of the moraine near Illinois Valley, thus creating a lake between the ice-front and the moraine, called Lake Lisbon (p. 164). It drained through two of several deep subglacial channels across the Marseilles moraine, one of which is the prominent gap in the moraine near the northeast corner of the Marseilles quadrangle (fig. 105), and the other occurs about three miles east of Yorkville in the Yorkville quadrangle. As other prominent subglacial channels, largely in the Yorkville quadrangle, extend as low as 710 feet and did not serve as outlets, and as sand deposits on the back slope of the moraine extend as high as 700 feet, the maximum elevation of the lake was between 700 and 710 feet. The level of the lake was lowered as the outlets were cut down to an elevation of about 650 feet or a depth of 60 feet. As a result these outlet channels now carry drainage from the east side of the moraine whereas the subglacial channels which did not serve as outlets do not.

For at least part of Lake Lisbon's duration the ice-front extended northeast-southwest through the site of the present village of Central, and drainage into the lake built a long delta of poorly assorted angular pebbly and cobbly gravel which now forms a broad low ridge, its iceward face being generally steeper. As shown on aerial photographs (fig. 106), the delta consists of two ridges which mark slightly different positions of the ice-front. When the delta was built Lake Lisbon was about 15 miles long and three to five miles wide.

No other distinctive shore features are found along the margin of Lake Lisbon, probably because its level was not stable as a result of fluctuating volumes of water and continuous erosion of the outlets. Some of the deposits of silt and clay in the area covered by Lake Lisbon may have been deposited in the lake but they are indistinguishable from similar deposits of later Lake Wauponsee.

When the ice-front had further retreated a short distance southeast from the delta it uncovered an area behind the moraine sufficiently low that Lake Lisbon drained southwestward into Lake Illinois. It is probable that for a short time this drainage followed the channel now occupied by the headwaters of North Kickapoo and Stanton creeks.

*Lake Illinois.*—As the ice-front retreated, Lake Illinois was extended up Illinois Valley and more deltas were deposited. Probably much of the valley itself, which had apparently been kept open by a subglacial stream, was filled with a



*Photograph by Illinois Agricultural Conservation Committee*

Fig. 105.—Aerial photograph of an area near the northeast corner of the Marseilles quadrangle showing the outlet channel of Lake Lisbon through the Marseilles moraine. The outlet channel appears as a band of uniformly dark colored soil crossing the mottled pattern of the soils on the Marseilles moraine. The line which angles from the top to the bottom of the photograph is a ditch in the channel. The crossroads near the southwest corner of the photograph is at the SW. corner sec. 19, T. 35 N., R. 6 E. (Big Grove Twp.), Marseilles quadrangle. Scale, about 3 inches per mile.

*Photograph by Illinois Agricultural Conservation Committee*

Fig. 106.—Aerial photograph of an area two miles south of Lisbon in which the Lake Lisbon delta (Central Ridge) appears as a light band in contrast to the uniformly dark soils of the Lake Wauponsee plain. The cross-roads near the center of the picture is one mile east of the Marseilles quadrangle at the SE. corner sec. 1, T. 34 N., R. 6 E. (Nettle Creek Twp.), Morris quadrangle. Scale, about 3 inches per mile.

large delta, small remnants of which still occur at a number of places along the valley.

The easternmost delta formed in Lake Illinois occurs in the SE. ¼ sec. 8, T. 33 N., R. 6 E. (Erienna Twp.), Marseilles quadrangle, where the State highway descends from the upland to the valley-flat, and indicates that Lake Illinois existed at least until the ice had withdrawn that far, but as no other Lake Illinois deltas have been found farther up Illinois Valley, it appears that the lake became drained shortly after the deposition of this delta and certainly before the advance of the Minooka ice.

As the dam of Lake Illinois at Peoria had withstood the normal volumes of glacial water provided by the melting of the Bloomington-Normal, Cropsey, Farm Ridge, Chatsworth, and Marseilles glaciers over an interval of thousands of years, its erosion in early Marseilles deglaciation must have required the outflow from the lake at that time of a volume of water much greater than had been provided by the melting of the previous glaciers. The abnormal volume of water is believed to have originated in the upper part of Fox Valley, especially above Elgin, where a great expanse and thickness of outwash associated with the retreat of the Marseilles glacier records a tremendous volume. It is believed that the volume of this water, which has been termed the Fox River Torrent, was so great that when it entered Lake Illinois it raised the level of the lake about 20 feet, inundated part of the upland north of Ottawa, and deposited the gravel and sand which occurs in broad, shallow channels at an elevation of about 620 feet.

*Post Lake Illinois.*—The receding Marseilles ice deposited only a comparatively thin smooth ground-moraine in the Morris basin, which accentuated the basin and suggests that the recession of the ice was the result of stagnation or melting in place, rather than a retreat of the ice-front as a result of melting exceeding rate of advance. In the central part of the basin the surface of the Marseilles drift was probably as low as 540 feet, but as the drainage outlet through Illinois Valley was probably little, if any, lower than 580 feet and possibly as high as 600 feet, depending on the altitude of the Marseilles drift (till and deltas) in the valley, a lake doubtless existed in the basin during the retreat of the Marseilles ice and subsequently until its outlet was cut down to 540 feet. The level of this lake and its outlet in post-Marseilles time cannot be ascertained, because any shorelines that it developed and any deposits that may have been made in it were eroded or were covered with deposits of later and higher lake levels, but it was probably above 560 and below 600 feet. How long it lasted is also questionable. It is not likely that its outlet channel along Illinois Valley through the Marseilles moraine was greatly if any eroded before the Marseilles ice had melted from the Morris basin, although erosion in the valley below the mouth of Fox River by the Fox River Torrent after Lake Illinois was drained may have been sufficient to accelerate erosion farther up the valley. The presence of laminated silt in the base of the Minooka moraine suggests that the lake was present when the Minooka ice advanced, although the age of these silts is not certain. The known existence of the later high lakes implies that the outlet was not cut very deeply prior to their existence.

At the end of Marseilles glaciation the ice-front retreated so far that when it readvanced as the Minooka glacier its alignment was markedly different, presumably as a result of a westward shift in the principal center of glaciation, and consequently the Marseilles glaciation is here considered the last of the Tazewell stage.

### *Loess Accumulation*

Loess accumulated on the drift plains throughout Tazewell time. The silt of which it consists was picked up by the wind from the floodplains of the rivers, the outwash plains along the ice-front, and perhaps from the till plains themselves before they were covered by vegetation. Much of the loess is so thin that it has been entirely leached of carbonates by weathering. However, where it is thick enough to have a calcareous zone at its base the underlying till is also unweathered, indicating that deposition of loess started soon after the area was vacated by the ice. Although fossils are rare in the loess in the Marseilles-Ottawa-Streator area they are plentiful in some places elsewhere and are of such a character as to indicate that the loess was deposited in areas covered by vegetation. Apparently vegetation covered the till plains soon after they were free of ice, and during the advancing stages of glaciation some plants probably persisted until overridden by the ice or destroyed by its melt-water. Although the lower part of the loess accumulated more rapidly than it could be leached, the absolute rate of accumulation was not rapid, as it seems probable that only the 2 feet of loess under the buried black silt layer on the Farm Ridge drift was deposited between the retreat of the Farm Ridge ice and the advance of the Marseilles glacier. The black silt layer probably resulted from cessation of loess deposition, the chilling of the climate and temporarily increased precipitation, and the consequent preservation of the organic matter. The remainder of the loess above the black silt is believed to have been deposited after the withdrawal of the Marseilles ice and, except for a minor amount, before the Cary drift was deposited, as very little material definitely recognizable as loess occurs on the Cary drift.

## CARY SUB-AGE

During Cary time the principal center of glaciation appears to have shifted westward to the Patrician area south of Hudson Bay.[22] None of the Cary glaciations covered the Marseilles-Ottawa-Streator area, but large volumes of melt-water from the Cary glaciers passed through the area along Illinois, Fox, and Vermilion valleys.

### *Minooka Glaciation*

As shown by the position of the Minooka moraine, the Minooka glacier advanced to about ten miles east of the Marseilles quadrangle, its front running almost due north from the junction of Kankakee and DesPlaines rivers, so that the melt-water from a considerable area of the Minooka glacier drained directly into Illinois Valley. Near Oswego the Minooka ice overrode the Marseilles moraine, and the melt-water north of there flowed into Fox Valley and thence into Illinois Valley. As the ice retreated from the moraine it deposited an extensive outwash plain in the Joliet area.[23] The great volume of water which transported and deposited these materials must have drained into the Morris basin and down Illinois Valley, but if it left any deposits in the Marseilles-Ottawa-Streator area they were later eroded or are not separable from later deposits.

### *Rockdale Glaciation*

After a retreat at the end of the Minooka glaciation, of unknown but probably no great distance, the ice-front readvanced to within a few miles of the Minooka moraine and there built the Rockdale moraine.[24] Again drainage from a large extent of ice was concentrated in Illinois Valley, and again if it left any deposits in the Marseilles-Ottawa-Streator area, they were later eroded or are not separable from later deposits.

### *Lemont Glaciation*

In the vicinity of Lemont and elsewhere in the Chicago area a distinctive glacial drift, called the Lemont drift, is exposed under the Valparaiso drift.[25] The drainage from the glacier that deposited the drift was carried through Illinois Valley.

### *Valparaiso Glaciation*

When the Valparaiso glacier attained its maximum extent (fig. 90), the melt-water from a vast area escaped through Illinois Valley. Kankakee Valley carried the drainage from that portion of the glacier that lay in northern Indiana, the lower peninsula of Michigan, and areas farther northeast. DesPlaines, DuPage, and Fox valleys carried the waters from that portion of the glacier that covered northeastern Illinois and southeastern Wisconsin.

The abundance of Valparaiso outwash along hundreds of miles of ice-front is evidence that unusually large volumes of

[22]Leverett, Frank, Moraines and shore-lines of the Lake Superior basin: U. S. Geol. Survey Prof. Paper 154, p. 18, 1929.

[23]Fisher, D. J., Geology and mineral resources of the Joliet quadrangle: Illinois Geol. Survey Bull. 51, pp. 79-87, 1925.

[24]Fisher, D. J., op. cit., pp. 87-89.

[25]Bretz, J H., Geology of the Chicago Region: Illinois Geol. Survey Bull. 65, Part I, General, p. 53, 1940.

melt-water issued from the ice, apparently because melting was more rapid than usual. In the Kankakee Valley the water constituted a flood with currents that transported slabs of limestone and built bars of rubble. The significance of these deposits was first recognized in the Kankakee area and the flood which formed them was called the Kankakee Torrent (p. 167).

*Kankakee Torrent.*—The volume of the Kankakee Torrent, supplemented by glacial waters from the DuPage and DesPlaines valleys, was so great, at least at times, that it could not escape along Illinois Valley through the Marseilles moraine and consequently it partially filled the Morris basin forming Lake Waupon-see (p. 167). It rose temporarily to an elevation of about 650 feet, at which level some of the water may have flowed through the channels cut across the Marseilles moraine by the outlet waters of Lake Lisbon.

The great flood of waters escaping down Illinois Valley, together with a considerable volume of melt-water supplied by melting of the Valparaiso ice in the Upper Fox Valley, exceeded the capacity of Illinois Valley through the Farm Ridge moraine and consequently a large area of upland between the Farm Ridge and Marseilles moraines was flooded to form Lake Ottawa (p. 168). Lake Ottawa doubtless attained its maximum height and extent at about the same time as Lake Wauponsee, but being downstream its maximum elevation was apparently about 10 feet lower or about 640 feet.

At its maximum elevation some of the Kankakee Torrent flowed south through the Iroquois River gap in the Marseilles moraine and flooded the Iroquois basin to a level of approximately 660 feet, forming Lake Watseka.[26] Lake Watseka in turn overflowed westward into the north fork of Vermilion River, and this overflow, together with backwater from the flood in Illinois Valley, formed Lake Pontiac (p. 168). Although Vermilion Valley was the principal outlet of Lake Pontiac, at its maximum elevation of about 650 feet some water apparently also flowed into Lake Ottawa through a low gap in the Farm Ridge moraine in the northeast corner of the Streator quadrangle.

There were sufficiently strong currents through these expanded river-lakes to erode broad shallow channels in till, and in these channels pebbles were concentrated as thin gravel deposits. Silt and sand settled out in the quieter waters in the marginal areas of the lakes. The higher elevations in the submerged areas were reduced by currents and waves and the depressions were more or less filled, so that the present surface of the areas is appreciably smoother than the areas above the levels of the lakes, and the approximate position of the shoreline is locally recognizable by a slight topographic change, especially on morainic slopes. However, by the very nature of these lakes, their levels must have fluctuated through many feet seasonally, if not daily, and the average level generally declined as the outlet channels were deepened and widened. Shore features such as beaches and wavecut cliffs were not developed under these conditions, and the deposits which are extremely thin at the highest levels become appreciable at the lower levels.

At many places the Kankakee Torrent eroded intensively. Where it was concentrated in the outlet through the Farm Ridge moraine just west of the Ottawa quadrangle, it eroded a distinct bench at the maximum elevation of 640 feet, stripped the glacial drift over a large area,[27] and even eroded the bedrock enough to produce an extremely rough or "scabland" topography. At its peak the torrent maintained a level of about 640 feet as far west as the Big Bend near Depue but farther down Illinois Valley, where the valley was large enough to carry the water without overflow, the level of the water declined and the glacial drift in the valley was eroded to a uniform level, which now remains as the highest terrace in the valley.

The principal inlet-to-outlet currents in Lake Ottawa eroded north of Ottawa broad but shallow channels which are followed by the present drainage lines. The

[26]Ekblaw, George E., personal communication.

[27]Cady, G. H., Geology and mineral resources of the Hennepin and LaSalle quadrangles: Illinois Geol. Survey Bull. 37, surficial geology map, Pl. I, in pocket, 1919.

broad valleys occupied by the headwaters of Clark Run and Pecumsaugan Creek were probably eroded by these currents. Currents from the upper Fox Valley were sufficiently strong to erode a few channels from the northeast. Between the channels the low undulations of the ground-moraine were modified by erosion so that on aerial photographs they show an orientation parallel to the channels.

On the south side of Illinois Valley the currents entering the lake curved to the south and deposited a shallow delta of fine gravel and sand over a large area between Illinois Valley and Covel Creek. Most of this material was probably eroded from the Marseilles moraine.

The network of shallow channels presumably cut by the melt-waters of the Farm Ridge ice during its recession were largely obliterated within the lake, as these channels terminate at the lake margin. The swampy areas now at the end of some of the channels may have been bays of Lake Ottawa.

The major current in Lake Wauponsee came from the Kankakee Valley but there was also a strong current from the DesPlaines-DuPage Valley. These currents eroded a wide gap in the Minooka moraine. The top of that part of the Minooka moraine north of Illinois River which lay within the lake was smoothed to a flat surface even less undulatory than many areas of ground-moraine, whereas farther north where the moraine rises above an elevation of 640 feet it has a typical morainic topography.

The Kankakee Torrent carried a large quantity of sand and silt into the lake, and the lake plain as far north as Coal City is generally underlain by sand. Farther north the deposits are essentially silt with some thin beds of sand and clay. As shown by auger borings, much of the Lake Wauponsee plain in the Marseilles quadrangle is covered by lake deposits, especially in the area below an elevation of 620 feet.

As the volume of the Kankakee Torrent declined, reduction of the levels of the lakes was reflected most prominently first in Lake Ottawa and its outlet. By the time Lake Ottawa had lowered 20 feet it was reduced to a lacustral river with a maximum width of about six miles, generally less. As the level continued to decline, the river eroded channels at successively lower levels near the present bluffs of Illinois Valley, the higher channels in till and the lower in bedrock, until at an elevation of approximately 540 feet it produced a flat-bottomed valley at least a mile wide, remnants of which constitute the Buffalo Rock terrace (p. 169). This level was probably equivalent to the Lake Morris stage in the Morris basin.

The amount of erosion along Illinois Valley is uncertain. The valley was probably at least half a mile wide at the beginning of the Kankakee Torrent and it is possible that the valley was widened about half a mile and was probably deepened, although the low gradient between lakes Wauponsee and Ottawa would encourage lateral erosion rather than deepening of the valley.

As the water-level was lowered and erosion proceeded in Illinois Valley, melt-water from the Valparaiso ice-front in the upper Fox River Valley also eroded the channel of Fox Valley until it produced a flat-bottomed valley, remnants of which constitute the Serena terrace (p. 170). Above Wedron the valley was eroded half a mile to a mile wide and a few feet of sand and fine gravel was deposited in it, but below Wedron it was not more than a quarter of a mile wide and was floored with bedrock. The valleys now represented by the Buffalo Rock and Serena terraces probably represent the same phase of erosion, and are also related to the terrace formed in the upper Fox Valley by outwash from the glacier which deposited the West Chicago moraine, the front of the Valparaiso system.

The Kankakee Torrent continued to flow into Lake Watseka and thence into Lake Pontiac until its level at Kankakee had lowered probably 10 or 15 feet. Meanwhile, as the water-level in Illinois Valley lowered, that of Lake Pontiac sank, and so it appears that lakes Ottawa and Pontiac diminished simultaneously. As the level of Lake Pontiac was lowered its width decreased and it became a broad lacustral river in the lower part of the basin. At this stage it eroded many interconnecting channels in the lake bed (fig. 107).

*Photograph by Illinois Agricultural Conservation Committee*

FIG. 107.—Aerial photograph of the Lake Pontiac plain near the southeast corner of the Streator quadrangle showing, as bands of dark-colored soil, the channels eroded by the Kankakee Torrent in the upland areas near the narrow valley of Vermilion River. The road corner in the central part of the photograph is at the SE. corner sec. 5, T. 29 N., R. 4 E. (Amity Twp.), Streator quadrangle. Scale, about 3 inches per mile.

Lake Pontiac was completely drained when the water-level in Illinois Valley was lowered to approximately 600 feet. Vermilion River then took a meandering course across the old lake flat, dependent largely on the inequalities of the surface and the low gradient. However, as Illinois Valley was cut down, Vermilion River also entrenched itself in bedrock, but intervals of stationary levels in Illinois Valley halted its downward cutting and despite its small volume enabled it to erode narrow flats, remnants of which remain as terraces. As many as four terraces are present at several localities. Although the exact correlation of these terraces is uncertain, it is possible that they are equivalent to the Buffalo Rock, Serena, Wedron, and Lake Chicago terraces in Illinois and Fox valleys.

Again, as the water-level was lowered and erosion proceeded in Illinois Valley, the Lake Wauponsee water-level also sank, probably accompanied by some erosion of the valley through the Marseilles moraine, until bedrock was reached at an elevation of 560 feet. Behind this bedrock barrier much of the Morris basin was inundated, forming Lake Morris (p. 167). Lake Morris was maintained at a level of approximately 560 feet long enough to form a beach, at least locally, as near Coal City. Where its outlet water was concentrated into Illinois Valley it eroded the bluff west of O'Brien Run, along the east side of the Marseilles quadrangle. Shallow channels converging near the outlet were eroded in the lake floor (fig. 108) and terminate sharply where eroded at the younger Cryder Lake shoreline (p. 172). Much of the sand below the 560-foot level south and southeast of Morris was probably carried into the lake from the Kankakee area.

It is probable that the 560-foot level of Lake Morris was not maintained long, as is suggested by the restricted presence of the beach, probably because the bedrock barrier in Illinois Valley was composed of soft sandstone and sandy shale that would erode rapidly. Lake Morris was drained when the outlet was cut down to 540 feet, about the level of the lowest part of the Morris basin, and the base of the valley at the close of the Kankakee Torrent was probably little if any below 540 feet.

After Lake Morris was drained, but probably still in Valparaiso time, Fox Valley was eroded about 20 feet below the Serena terrace or to the level of what is now the Wedron terrace (p. 171). The river laid down a thin deposit of gravel and sand at Wedron and farther up the valley, but below Wedron it occupied a narrow bedrock channel. This level is believed to be the same as that of a terrace in the upper Fox Valley which is thought to have been formed by melt-water from the ice-front during the Fox Lake interval of Valparaiso time.

### *Tinley Glaciation*

Soon after the ice-front retreated from the position of the Valparaiso moraine in northeastern Illinois it readvanced and deposited the Tinley moraine[28] along the back slope of the Valparaiso moraine. No deposits of Tinley age have been identified along Illinois Valley although Tinley melt-water must have passed through the valley.

## LATE CARY AND MANKATO SUB-AGES

### *Lake Chicago Time*

As the glacier receded after depositing the Tinley moraine, the melt-water accumulated between the ice-front and the moraine to form Lake Chicago, the glacial ancestor of Lake Michigan. The glacial lake existed throughout the remainder of Cary time and all of Mankato time and then without interruption continued as Lake Michigan, although its areal extent and the level of the water fluctuated repeatedly because of retreats and readvances of the ice-front and opening and closing of various outlets and connections with other of the Great Lakes basins. Despite its length and complexity and the obscurity of the records of many stages, the history of the lake has been well deciphered.[29]

[28]Bretz, J H., Geology of the Chicago region: Illinois Geol. Survey Bull. 65, Part I, General, p. 50, 1940.

[29]Leverett, Frank, The Pleistocene features and deposits of the Chicago area: Chicago Acad. Sci. Bull. 2, 1897.

Leverett, Frank, The Illinois glacial lobe: U. S. Geol. Survey Mon. 38, pp. 418-459, 1898.

Alden, W. C., U. S. Geol. Survey, Geol. Atlas of U. S., Chicago Folio (No. 81), 1902.

Leverett, Frank, and Taylor, F. B., The Pleistocene of Indiana and Michigan and the history of the Great Lakes: U. S. Geol. Survey Mon. 53, 1915.

*Con't. on p. 227.*

*Photograph by Illinois Agricultural Conservation Committee*

FIG. 108.—Aerial photograph of an area on the north side of Illinois River along the east side of the Marseilles quadrangle, showing (1) the distinctive soil-pattern of the intricately eroded surface of the Ottawa terrace in the lower half of the picture, (2) the Cryder Lake shoreline marked by the distinct change in soil-pattern curving across the center of the picture, (3) the Lake Morris plain extending from the Cryder Lake shoreline to O'Brien Run in the northwest part of the photograph, (4) channels in the Lake Morris plain revealed by bands of dark soil, and (5) the Lake Wauponsee plain northwest of O'Brien Run. The cross-roads near the center of the west side of the picture is at the Young School at the NW. corner sec. 11, T. 33 N., R. 6 E. (Erienna Twp.), Marseilles quadrangle. Scale, about 3 inches per mile.

One of the principal outlets of Lake Chicago, known as the Chicago Outlet, was through the Tinley and Valparaiso moraines along DesPlaines Valley and thence into Illinois Valley, and through it a large volume of water was discharged at the Glenwood, Calumet, and Toleston stages. The shoreline of the lake at each of these stages is marked by a distinct beach, indicating that the water-level and consequently the outflow was maintained for many years at each stage. The levels are about 20 feet apart and the lowest is about 20 feet above Lake Michigan. The Outlet River intensively eroded the Des-Plaines and Illinois valleys, deepening Illinois valley in the Marseilles and Ottawa quadrangles probably as much as 40 feet, and developing at that level the valley-flat which remains as the Ottawa terrace (p. 173 and fig. 108). This valley-flat represents the net result of erosion at the close of the last Outlet stage, when waters evidently covered the valley-floor from bluff to bluff. Similar valley-flats had been eroded at successively lower levels by the preceding Outlet stages, but in the Marseilles-Ottawa-Streator area they were all eroded by the later stages, except south of Seneca where a few local narrow benches occur 10 to 20 feet above the Ottawa terrace.

Remnants of various erosional levels formed in Lake Chicago time are more abundant along the tributary valleys than in Illinois Valley. Along Fox Valley the Sulphur Springs Terrace (p. 174) and the Indian Creek Terrace (p. 174) and probably one or more of the low terraces along Vermilion Valley apparently mark valley-broadening intervals at temporary base-levels controlled by levels in Illinois Valley.

In the Morris basin, mostly east of the Marseilles-Ottawa-Streator area, where Illinois Valley was limited by low walls of unconsolidated materials, it was greatly widened by Outlet River to a lacustral river which was named Cryder Lake.[30] The Cryder Lake shoreline at an elevation of 545-550 feet, the highest continuous shoreline in the Morris basin, is thought to mark the highest level of the Outlet waters in the Morris basin, although it may have been topped temporarily during brief periods of unusually large floods. It is distinctly an erosional escarpment 20-25 feet above a surface in large part eroded on much older glacial deposits or on bedrock. Below an elevation of about 520 feet the surface of the older deposits is channeled and numerous bars of coarse gravel, similar to the deposits of Outlet River farther up the valley, are present. The greater part of the erosion of the Cryder Lake shore probably occurred during the Glenwood and Calumet stages, although even the Toleston waters may have reached to the base of the Cryder shore, as they certainly covered all the area below a level of 520 feet.

The Toleston waters left in Illinois Valley in the Marseilles-Ottawa-Streator area only a few deposits, mostly in the lee of rock protections such as Buffalo Rock or in the channels cut below the general level of the bedrock surface, and the high degree of sorting, the medium to coarse size, the high degree of rounding, and the almost spherical shape of the pebbles in these deposits testify to the strength and erosive power of the Outlet River and the distance that the materials were carried. The material, largely dolomite from exposures along DesPlaines Valley at and above Joliet, is similar to the Outlet River gravels near Morris, Channahon, and Joliet and is distinctly different from the poorly sorted more or less angular gravel in the Kankakee Torrent deposits, whose materials were derived principally from the local bedrock and glacial drift. It also differs from the Lake Illinois delta deposits which accumulated near the ice-front.

In Toleston time the Outlet River plunged over a 30-40 foot falls or steep cascades in the St. Peter sandstone about a mile west of Ottawa. Above the falls the sandstone is intricately carved by steep-sided channels which range up to 20 feet across and 15 feet deep. A thin cover of Platteville limestone, filling a channel about a mile wide in the top of the St. Peter sandstone across Illinois Valley a short distance above the waterfalls, was

[29]—*Con't.*

Baker, F. C., The life of the Pleistocene or glacial period: Univ. Illinois Bull., vol. 17, No. 41, 1920.

Leverett, Frank, Moraines and shore lines of the Lake Superior region: U. S. Geol. Survey Prof. Paper 154, 1929.

Ekblaw, George E., Some evidences of incipient stages of Lake Chicago: Illinois Acad. Sci. Trans., vol. 23, pp. 387-390, 1931.

Bretz, J H., Geology of the Chicago region: Illinois Geol. Survey Bull. 65, Part I, General, pp. 102-116, 1940.

[30]Culver, H. E., Geology and mineral resources of the Morris quadrangle: Illinois Geol. Survey Bull. 43, p. 180, 1923.

more resistant to erosion than the sandstone and was partially responsible for development of the falls, but except near the north bluffs the falls was entirely in sandstone and was probably migrating headward rapidly when the Chicago Outlet was abandoned by the lowering of the level of Lake Chicago.

Erosion of the large valleys and ravines tributary to Illinois Valley was started after the retreat of the Marseilles ice, and they were probably deepened considerably when the Kankakee Torrent erosion lowered the level of the valley. However, the greater part of their development appears to have occurred in Lake Chicago time, as only a few of the larger valleys contain high-level benches which might be equivalent to levels earlier than Lake Chicago. The amount of erosion since Lake Chicago time is slight, as shown by the fact that many of the tributary streams, especially in the Marseilles quadrangle, enter Illinois Valley at the level of the Ottawa terrace, having neither trenched the terrace nor built large alluvial fans on it. Some small ravines which have been formed since Lake Chicago time have built fans comparable to their size on the terraces. The steep valley-walls behind the Lake Chicago terraces are obviously inherited from Lake Chicago time.

### Recent Age

The final retreat of the Wisconsin glaciers marks the beginning of the Recent age. During Recent time the Wisconsin drift has been leached of carbonates to a depth of about 30 inches, but as this depth is much less than that developed on earlier drifts during the interglacial ages, it is recognized that the Recent age may possibly be the early part of another interglacial age. As there has been no marked change in conditions in the Marseilles-Ottawa-Streator area since the last waters from Lake Chicago passed along Illinois Valley, all the events since then are considered to be Recent in age, and in the upland areas, which were not affected by the Lake Chicago waters, many of the events included in the Recent may have begun as early as late in the Cary sub-age, after the formation of the widespread mantle of loess.

Vegetation covered the area soon after the glacier withdrew, and weathering produced prairie soils on the flat upland areas covered by prairie vegetation and forest types of soils along the bottomlands and the slopes of the valleys where forests flourished.

Most of the changes in the area during Recent time have been caused by rainfall. Probably the amount of rainfall has varied somewhat throughout Recent time, as some climatic fluctuations have occurred, but it appears to have been sufficient to support continuously a cover of vegetation. Evidence in other areas indicates that during much of the Recent age the climate was somewhat warmer than at present.

Throughout Recent time the rainfall flowing over the surfaces as sheet-wash or concentrated in rivulets, streams, and rivers has been slowly wearing away the land. Comparatively little has been accomplished along the major valleys, as the present rivers inherited valleys carved by great glacial floods, in comparison with which their erosive efforts have been trivial. Illinois River, for example, is entrenched in the Ottawa terrace in a channel that was probably carved mostly in late glacial time and although it has widened the channel somewhat, it has probably deepened it very little. Many short deep ravines have been eroded in the high bluffs. A large alluvial fan on the Ottawa terrace at the mouth of a sharp ravine in the south bluff of Illinois Valley about two miles southwest of Seneca shows that the ravine has been formed mainly since the Lake Chicago waters covered the terrace. Erosion has degraded the valleys of many streams 5 to 10 feet in Recent time and has broadened them by undercutting their valley-walls until landslides occur. The loose material of the slides is carried away by the streams.

The effect of sheet-wash is evident almost everywhere. During heavy rains the water runs down the slopes in sheets, transporting fine material into the depressions and gradually leveling off the irregularities of the surface. In the morainal areas of the uplands sheet-wash is in part responsible for the concentration of organic material, clay, and silt in the depressions, and together with oxidation it also hinders the accumulation of and removes organic material from the slopes. Consequently the soil on the slopes is thin and light-colored and the soil in the depressions is dark (figs. 12, 105). In the bottomlands a deposit of silt or sandy silt with scattered pebbles formed by sheet-wash occurs at the base of the bluffs, especially where the bluffs consist largely of unconsolidated materials.

The sheet-wash of the upper slopes is commonly concentrated by the irregularities of the surface into rivulets and these, often in the course of a few hours' rain, excavate sharp gullies in slopes that are unprotected by vegetation and build fan-shaped deposits on the flats at the base of the gullies.

The material eroded by the streams and rivers is transported down the valleys. Some of the materials carried into Illinois River are deposited in bars in the channel where it becomes a hindrance to navigation, especially at the mouths of tributary streams. During floods the streams and rivers overflow their channels and by depositing sand, gravel, and silt in the quieter waters build up floodplains. In periods of unusually high water some of the terraces are flooded, especially in many of the channels in Ottawa terrace and in the lower part of Fox Valley where ice-jams in the narrow valley cause high water-levels.

Swamps were formerly extensive in some of the depressions on the Ottawa terrace in Illinois Valley, and plant debris which accumulated in them formed deposits of peat. Smaller deposits of peat also formed in some of the upland depressions that were probably formerly ponds or lakes. Most of the swampy areas have been artificially drained, and in those that were drained many years ago the peat has gradually oxidized and disappeared.

During Recent time the groundwater has deposited silica, calcium carbonate, limonite, and pyrite in the interstitial spaces of the rocks, locally cementing some of the unconsolidated rocks. At some places along the valleys the groundwater has deposited tufa and travertine at the mouths of springs.

At a few places the wind has formed small dunes and, especially during dry periods in the spring, it has picked up some fine dust from the plowed fields. Some dust has been carried into the area in dust storms.

With the advent of man the geologic history may properly be brought to a close. The various animals which inhabited the "wilderness" before man arrived left little mark on its geologic features. Man, however, with his ability to build structures to add to his comfort and wealth, used the natural resources of the area and in so doing modified the geologic processes and altered the natural topography. The earliest man known to have inhabited the area heaped the soil in mounds for dwelling and burial places, used the clays to make pottery, and shaped the hard rocks into tools and weapons. The later Indians plowed the soils along some of the major valleys and raised corn.

When the white man arrived, development of the natural resources began on a much larger scale. The earliest settlers built dams across the rivers for water-power to grind flour. Settlement and development of the area was greatly accelerated by excavation of the Illinois and Michigan canal. Before many years passed, coal, clay, shale, silica sand, limestone, sandstone, sand, and gravel were all being exploited. As a result the topography was altered by mines, pits, and heaps of waste debris and by sinkholes which formed where mine-roofs collapsed. Almost countless are the excavations for buildings, highways, railroads, canals, dams, and wells. Deforestation and plowing of the land have increased the amount and rate of runoff of the rainfall, which has in effect rejuvenated the streams so that they have eroded their earlier floodplain deposits and thus produced low terraces along some of the valleys. Plowing of the sloping land near the valleys has locally resulted in increased erosion which has reduced the fertility of the soils. The building of dams along Illinois, Fox, and Vermilion valleys has decreased erosion along parts of these valleys, and the lakes thus formed are gradually filling with sand, silt, and clay.

As recorded human history serves to guide man's endeavors toward a higher standard of civilization, so geologic history serves to bring a greater appreciation of his rich heritage of natural resources and should lead to their increased development and more efficient conservation.

# CHAPTER IX—MINERAL RESOURCES

BY
H. B. WILLMAN

## INTRODUCTION

BY
W. H. VOSKUIL

In succeeding sections there is given a detailed description of the character, location, and present utilization of minerals which are of commercial value in the manufacturing industries, in building and road construction, and for use as fuel and power. With several of these minerals, notably silica sand, clay and shale, coal, sand and gravel, and sandstone, the area is amply endowed, but others, such as limestone and natural-bonded molding sand, are present in limited quantities, and the metals and the highly desirable petroleum and natural gas have not been found in commercial quantities.

All of the minerals that are used in commerce and industry and that are present in the area have a potential value, provided that they can be delivered to consumers in local or distant markets under conditions as favorable or more favorable than competing materials from other mining districts. In order to evaluate the commercial possibilities of the mineral deposits in the Marseilles-Ottawa-Streator area, it is necessary to consider:

1. The nature of the mineral and its functions in industrial society.
2. The market radius within which a given mineral product can move and the approximate quantity of consumption within this radius.
3. The competitive relationships of the mineral to similar minerals in neighboring mining districts.
4. Market outlets for minerals in the local community.
5. Transportation facilities.

### TYPES OF ECONOMIC MINERALS

Minerals of economic utility may be classified for convenience into four groups, namely:

1. Energy resource minerals—coal, oil, and natural gas.
2. Metals—basic raw materials for the manufacture of industrial and agricultural machinery and equipment, transportation equipment, and for use in various types of construction.
3. Materials of construction—sand, gravel, limestone, cement rock, clay and shale, glass sand.
4. Industrial minerals—minerals used as chemical raw materials, abrasives, molding sands, fluxing materials, etc.

The characteristics of the market for each of these groups of minerals varies notably in radius of the market area and in the diversity of uses for the material. Attempts to develop these potential minerals for commercial purposes therefore require a careful and detailed analysis of costs of development and production, market prices, extent and location of possible market outlets, costs of transportation, and available transportation facilities. For some of the minerals the markets must necessarily be local, while for others the radius extends beyond the immediate boundaries of the locality.

### THE LOCAL MARKET

The area included in this report has a population of approximately 60,000. About 35,000 people live in the three larger cities of Ottawa, Streator, and Marseilles. The remainder occupy farms or live in smaller communities. Mineral industries in the area[1] are as follows:

[1] In addition, many small sand and gravel pits and local coal mines are intermittently operated.

| Company | Product |
|---|---|
| *Dayton* | |
| Fox River Clay Works | Clay |
| *Lowell* | |
| Conco-Meier Co. | Face brick |
| *Ottawa* | |
| Acme Silica Sand Co. | Silica sand |
| Aetna Sand and Gravel Co. | Silica sand |
| American Silica Sand Co. | Silica sand |
| Bellrose Sand Co. | Silica sand |
| Buffalo Rock Coal Co. | Coal |
| Chicago Retort & Firebrick Co. | Refractories |
| Illinois Silica Sand Co. | Silica sand |
| Libby-Owens-Ford Glass Co. | Glass |
| Lockwood Glass Co. | Glass |
| Moline Consumers Co. | Sand and gravel |
| National Fireproofing Corp. | Structural tile |
| Osage Coal Co. | Coal |
| Ottawa Hydraulic Sand Co. | Silica sand |
| Ottawa Mining Co. | Coal |
| Ottawa Road Gravel Co. | Gravel |
| Ottawa Silica Co. | Silica sand |
| Peltier Glass Co. | Glass |
| Rugg Glass Co. | Glass |
| C. E. Taylor Sand Co. | Sand |
| Standard Silica Co. | Silica sand |
| Starved Rock Coal & Mining Co. | Coal |
| Wedron Silica Co. | Silica sand |
| Wilmington Coal Mines | Coal |
| *Streator* | |
| Bee, Richard J. | Coal |
| Commercial Cullet Co. | Glass |
| French Coal Co. | Coal |
| Jenkins, Daniel | Cement blocks |
| Owens-Illinois Glass Co. | Glass |
| Purington Paving Brick Co. | Brick and tile |
| Streator Brick Co. | Brick and tile |
| Streator Clay Products Co. | Brick and tile |
| Streator Drain Tile Co. | Brick and tile |
| Thatcher Mfg. Co. | Glass |
| Cephas Williams Gravel Co. | Sand and gravel |
| *Marseilles* | |
| Illinois Valley Coal Co. | Coal |
| Kickapoo Mining Co. | Coal |
| Silver Clay and Coal Co. | Clay and coal |
| Spicer Gravel Co. | Sand and gravel |
| Standard Silicate Co. | Sodium silicate |
| *Utica* | |
| George M. Pendergast and Co. | Silica sand |
| Philadelphia Quartz Co. | Sodium silicate |
| *Wedron* | |
| Wedron Silica Co. | Silica sand |

## Market for Coal

The area included in this report is an exceptionally large consumer of coal. Coal consumption in LaSalle County, as reported in a survey of fuel consumption by counties, made by the Bureau of the Census in 1929, is given in table 10.

Consumption of coal has probably declined somewhat since 1929 owing both to increased efficiency in coal use and to a decline in industrial activity.

Except for occasional local mines, the coal industry depends upon a larger market area than the one described in this report. In Illinois, coal mining is carried on in nearly half of the counties of the State and competition in the market is keen. The principal outlet for coal mines in northern Illinois, other than the local market, is the Chicago area. Into this market is shipped coal from practically all important coal-producing districts in Illinois, Indiana, and western Kentucky together with substantial quantities from eastern fields. In the Chicago market the competitive position of coal-fields in this district depends upon comparative freight rates, costs of production, quality of coal, and types of consumers buying coal.

*Freight rates.*—The district has a slight advantage in freight rates over other producing districts in Illinois as shown by the following rates from representative districts to Chicago:

| | |
|---|---|
| Atkinson | $1.48 |
| Belleville and Duquoin | 1.95 |
| Springfield and Centralia | 1.75 |
| Danville | 1.45 |
| Fulton | 1.65 |
| Peoria | 1.53 |
| Southern Illinois | 2.05 |
| Marseilles-Ottawa-Streator area | $1.20-$1.30 |

Quality of coal and costs of mining are such variable elements that comparisons can be made only after a detailed study and analysis of a particular coal, its geologic setting, cost of development, accessibility to transportation lines, and the types of markets into which it is to be sold.[2]

## Market for Silica Sand

Among the mineral deposits of the area, silica sand offers possibilities of promoting further industrial development of the community. At the present time Illinois exports substantial quantities of sand for glass-making purposes while also importing glass products from distant sources. Although Illinois ranks first in glass-sand output, it is fifth in value of manufacture

[2]Cady, G. H., Classification and selection of Illinois coals: Illinois Geol. Survey Bull. 62, 1935.

TABLE 10.—COAL CONSUMPTION IN LASALLE COUNTY, 1929
IN TONS

| | Manufacturing | Mining | Public Utility | Domestic heating | Total |
|---|---|---|---|---|---|
| Anthracite | 84,200 | ........ | ........ | (a) | 84,200 |
| Bituminous | 1,161,704 | 65,010 | 3,480 | 140,000(b) | 1,370,194 |
| Coke | 10,696 | ........ | ........ | .......... | 10,696 |
| | | | | | 1,465,090 |

a included in b
b estimated

of glass products. Glass manufacture began on the Atlantic seaboard and moved westward with the movement of population, aided by the opportune discovery of natural gas fields in the Appalachian and Ohio Valley states. As long as glass was made by hand, the abandonment of established factories in favor of new establishments near cheap fuel supplies and growing markets involved no great loss of capital investment, and migration of glass plants was rapid. With the introduction of expensive machinery, notably the Owens bottle-making machine in 1895, with its high-capital costs, glass establishments became less mobile, and there was a greater lag between the westward movement of markets and the migration of the glass industry. However, the location of industrial enterprises is constantly changing in favor of more economical relations between raw materials and markets, and glass-making facilities in the midst of the large glass markets of the Upper Mississippi Valley will ultimately be enlarged.

The usefulness of glass in industry, in construction, and in household utensils is due to its transparency, resistance to corrosion, and ductility. Glass products fall into two general market groups, namely, those which are manufactured directly for consumer use and those which enter into the construction of or form part of a larger article of trade. The former group includes such items as tableware, fruit jars, lamp chimneys and globes, milk bottles, etc. The latter group is comprised of such items as building glass, beverage containers, lamp bulbs, and chemical and pharmaceutical glassware. Market characteristics differ for each group and vary within the groups themselves. The market for that group of glass products which is sold directly to consumers will be governed by such items as distribution of population and variations in the purchasing power from one period to another. These same items also govern more or less the purchase of glass materials which are used by manufacturers in the fabrication of other consumer goods (for example, plate glass in an automobile) with this important difference: the immediate marketing point for glass products used in the further manufacture of goods is determined by the location of the fabricating plant or plants. Thus the market for approximately 50 per cent of the plate-glass output is determined by the location of automobile factories, and the market for lamp bulbs is determined by the location of electric-lamp factories. Again, the marketing point for certain types of glass goods is determined primarily by the location of factories using glass as, for example, bottles used in the beverage industry, where the industry itself is governed more or less by population distribution.

The market for certain types of glass products may, in some instances, be restricted to a very small number or even one producer when the product requires a high degree of skill or specialization or where one manufacturer is able to dominate the field to the exclusion of possible competitors. The complexities of market factors must be analyzed in an attempt to evaluate the feasibility of a new or enlarged glass manufacturing industry in a given locality.

### Market for Clay and Shale

The clay and shale resources of the area have two distinct markets, viz., as a material for the manufacture of building materials and as a refractory material for use in the metallurgical industries. Structural clay products find their most important outlet in the Chicago district, which is a large consumer of face brick, but they are also marketed in a large area in northern Illinois. Refractory clay products are marketed mainly in the Chicago industrial district. Eight plants in the area are engaged in the production of clay and the manufacture of structural and refractory clay products.

### Market for Sand and Gravel

Outlets for sand and gravel are practically limited to use in the immediate locality for road surfacing, road aggregates, and local building construction.

The market for sand and gravel is one of the most difficult to analyze. Demand for these materials may vary widely from year to year due sometimes to the fluctuations in business activity and sometimes to changes in local demand only. Two types of markets may be distinguished for sand and gravel materials, a single-order market and a recurring-order market. The former is illustrated by the demand created locally for material of this type when a paved highway is being built in the immediate locality. The second type of market is more likely to be a response to diversified activities among which are: house building, secondary road construction and maintenance, local paving of streets and walks, and miscellaneous activities.

## SILICA SAND

More silica sand is produced in the Ottawa area than in any other area in the United States. The source of this sand is the St. Peter sandstone which is composed almost entirely of nearly pure silica grains. Because it is unusually pure and is only slightly consolidated, which facilitates mining, the sandstone has been an important source of silica sand since the middle of the nineteenth century when several glass factories were located in the area.

In the Ottawa quadrangle the St. Peter sandstone is exposed in the bluffs and in the terraces along Illinois Valley almost continuously from the west side of the quadrangle to the mouth of Fox River at Ottawa. It crops out at many places along Fox Valley in both the Ottawa and Marseilles quadrangles (pls. 1, 2). Because of the gentle easterly dip of the strata the top of the formation gradually lowers eastward from the top of the bluffs at Starved Rock to the level of the Illinois Valley floor at the mouth of Fox River.

Well records show that near Ottawa the sandstone is 135 to 160 feet thick where overlain by younger bedrock strata. It is much thinner where eroded along the valleys, and in the Illinois Valley floor near Starved Rock it has been completely eroded.

The upper part of the St. Peter sandstone is a uniform well-sorted medium-grained sandstone, while the lower part is similar but fine-grained (fig. 33). The sandstone is white, yellow, or brown, and most of it is so loosely cemented it can be easily broken down by the fingers to an incoherent sand. The sand grains are largely rounded fragments of quartz and most of the sandstone naturally contains more than 97 per cent silica. When the small amount of clay and other impurities are removed by washing, the sand contains more than 99 per cent silica, and some prepared sand contains more than 99.8 per cent silica (app. H, table 1, Nos. 1-8).

The distribution, thickness, and character of the St. Peter sandstone have been described in detail in the chapter on stratigraphy (pp. 71-80).

### USES

The St. Peter silica sand has scores of uses[3] in many industries. Some industries use it principally because of its chemical composition, others principally because of

[3]Lamar, J. E., Geology and mineral resources of the St. Peter sandstone in Illinois: Illinois Geol. Survey Bull. 53, pp. 99-142, 1928.

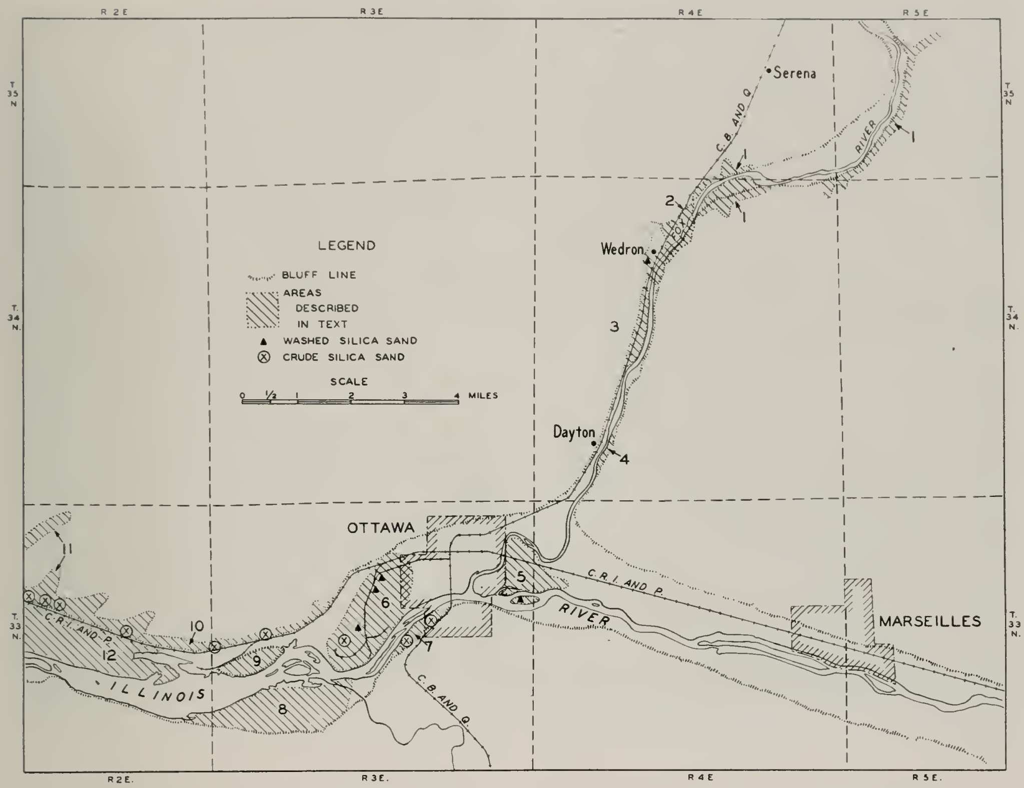



Fig. 109.—Location of the operating silica-sand pits and the areas described.

Table 11.—Producers of Silica Sand

| Company | Town | Location (Ottawa quadrangle) | | | | | |
|---|---|---|---|---|---|---|---|
| | | ¼ | ¼ | ¼ | sec. | Twp. | Range |
| *Washed sand* | | | | | | | |
| American Silica Sand Co. | E. of Utica | NE | SE | SE | 9 | 33 N | 2 E |
| Ottawa Hydraulic Sand Co. | E. of Ottawa | NE | SW | SE | 12 | 33 N | 3 E |
| Ottawa Silica Co. Plant A | W. of Ottawa | NW | SW | NW | 10 | 33 N | 3 E |
| Ottawa Silica Co. Plant B | W. of Ottawa | NW | NW | SW | 10 | 33 N | 3 E |
| Ottawa Silica Co. Plant C (idle) | W. of Ottawa | SW | NE | SW | 16 | 33 N | 3 E |
| Standard Silica Co. | W. of Ottawa | NW | SE | NE | 16 | 33 N | 3 E |
| Wedron Silica Co. | Wedron | NW | NW | SE | 9 | 34 N | 4 E |
| *Crude sand* | | | | | | | |
| Acme Silica Sand Co. | W. of S. Ottawa | SW | NW | NW | 14 | 33 N | 3 E |
| Aetna Sand and Gravel Co. | W. of Ottawa | NE | NE | SW | 16 | 33 N | 3 E |
| American Silica Sand Co. | N. of Buffalo Rock | SE | SW | NW | 17 | 33 N | 3 E |
| American Silica Sand Co. | E. of Utica | SE | SE | NW | 14 | 33 N | 2 E |
| Bellrose Sand Co. | W. of S. Ottawa | SE | SW | NE | 15 | 33 N | 3 E |
| Bellrose Sand Co. | E. of Utica | SE | NW | SE | 9 | 33 N | 2 E |
| Illinois Silica Sand Co. | NW. of Buffalo Rock | SW | NW | SE | 13 | 33 N | 2 E |
| George M. Pendergast & Co. | E. of Utica | SE | SW | SW | 10 | 33 N | 2 E |

Fig. 110.—Hydraulic mining of silica sand in the pit of the Ottawa Silica Company west of Ottawa.

such physical properties as hardness, refractoriness, roundness, grain size, and whiteness. The washed and screened sand has been most extensively used for glass sand, steel-molding sand, blast sand, grinding and polishing sand, the manufacture of chemicals such as sodium silicate and carborundum, mortar sand, plastering sand, fire or furnace sand, filter sand, roofing sand, engine sand, and Ottawa standard testing-sand. The pulverized washed sand is used in the manufacture of glazes, metal polishes, abrasive soaps, composition flooring, paint fillers, and other uses. The crude sand is used principally for steel-molding sand, core sand, fire or furnace sand, and welding sand.

The medium-grained sand in the upper part of the formation has been the principal source of sand for nearly all these uses. The fine-grained lower sand has also been used for these purposes where mixed with the medium-grained sand in quarrying. Where the fine-grained sand has been mined separately it has been used principally for fire or furnace sand and welding sand.

The manufacture of glass normally consumes the largest quantity of sand, and steel molding uses a somewhat smaller quantity. These two uses together take more than 75 per cent of the sand produced.

### INDUSTRY

The silica-sand industry has been active for many years and enormous quantities of sand have been shipped from the area. The factors favoring the development of the industry have been the unusual chemical purity of its sand, the presence of large deposits with little overburden, the ease with which it can be mined, the greater coarseness of the sand than in other areas, its proximity to the Chicago industrial area, and its favorable location along some of the first lines of transportation in Illinois—the Illinois and Michigan Canal and the Chicago, Rock Island and Pacific Railroad.

A factor favoring the exploitation of the St. Peter sand, particularly in the Ottawa area, is its somewhat coarser grain size

Fig. 111.—View of the pit of the Ottawa Silica Company west of Ottawa, showing the hydraulic system of mining silica sand, and the two plants where the sand is washed, dried, and screened.

than elsewhere in the Middle West.[4] In the Ottawa area the upper medium-grained part of the formation contains 30-50 per cent, or locally more, of grains coarser than 40-mesh; in Minnesota the St. Peter sand, except for a relatively thin upper member, contains only 9 per cent of this size (av. 72 samples); in Wisconsin, 10 per cent (average 24 samples); in Missouri, 5 per cent (average 8 samples); and in Arkansas, 13 per cent (average 11 samples). These sands are about the same grain size as the lower fine-grained sand in the Ottawa area. As sand coarser than 40-mesh is preferred for some uses, such as sandblasting, only a small percentage of that grade could be produced from the finer grained sands.

Many of the operations are favorably located to ship sand on the Illinois Waterway, and some shipments have recently been made by water. Use of the Waterway may permit an expansion of the market area, especially in the eastern steel-manufacturing areas to which sand can be transported either through the Great Lakes or the Mississippi and Ohio waterways.

The industry consists of two types of operations—the production of washed sand and the production of crude sand (table 11). The locations of the active pits are shown in figure 109. The many crude-sand pits in the north bluff of Illinois Valley, in Buffalo Rock, and at Wedron (pl. 5) were formerly worked by separate companies which were later consolidated and production is now confined to a few pits.

### MINING AND PREPARATION[5]

In early times the St. Peter sandstone was mined in underground mines, some of which occur in the north bluff of Illinois Valley north of Buffalo Rock. All present operations are in open pits or quarries. The producers of washed sand

[4]Thiel, G. A., Sedimentary and petrographic analysis of the St. Peter sandstone: Geol. Soc. America Bull., vol. 46, fig. 12, p. 578, 1935.

[5]Lamar, J. E., op. cit., pp. 63-98.

FIG. 112.—Production of crude sand at pit formerly operated by the Ottawa Silica Molding Sand Company west of Ottawa, near center SE. ¼ sec. 18, T. 33 N., R. 3 E., (Ottawa Twp.), Ottawa quadrangle. (Illinois State Geological Survey Bull. 53, p. 94.)

use a hydraulic method of mining (figs. 110, 111). In this process the sandstone is partially broken down by blasting and it is then washed by a stream of water under high pressure into a collecting basin or sump from which it is pumped to the plant. By this treatment the sandstone is broken down into individual sand grains. In the plant it is thoroughly washed, and after drying it is screened to meet the specifications for various uses.

In producing crude sand the process consists usually of blasting, and then loading the cars or belt conveyors by power shovels or dragline scrapers (fig. 112). Usually the large lumps are caught on grizzly bars and broken down by hand, and the smaller lumps are reduced by a crusher, but in some operations the sand is loaded directly to railroad cars without crushing.

## RESOURCES

The resources of St. Peter sandstone in the Ottawa area are almost inexhaustible and nearly all the present quarries have large reserves. Many sites for new pits are present and a large number of quarries which have not been operated recently could be reopened if warranted by an increased demand for silica sand.

The exposures of the sandstone in the present pits indicate that, in general, the whitest and therefore the sand most suitable for washing underlies the terraces in Illinois and Fox valleys. Where the sandstone has an overburden of glacial drift, mostly till, as in the Illinois Valley bluffs near Utica and at many places along Fox Valley, it is slightly more discolored by iron oxide but is less colored than where the sandstone has an overburden of Pennsylvanian strata.

New pits located at or near the top of the sandstone have available a thickness of about 150 feet of sandstone. However, in selecting a quarry site it should be noted that only the upper 75 to 100 feet of the formation, and locally considerably less, is medium-grained while the lower part is fine-grained.

The information about the areas described below is based almost entirely on outcrops, and before any extensive developments are undertaken the deposits should be drilled to determine accurately the thickness and character of the overburden, and chemical and sieve analyses of samples of the sand obtained by drilling should be made. The locations of the areas are shown in figure 109.

*Area 1, south and east of Serena.*—The St. Peter sandstone underlies several large terraces along Fox Valley in the Marseilles quadrangle and in part of these it has only a thin overburden of sand and gravel. The largest terrace extends along the north side of the valley for nearly three miles southeast of Serena in secs. 29-31, T. 35 N., R. 5 E., and secs. 35, 36, T.

35 N., R. 4 E. (Serena Twp.). Similar but smaller terraces occur along the south side of the valley two miles south of Serena in secs. 2, 3, T. 34 N., R. 4 E. (Rutland Twp.), and along the east side of the valley two miles northeast of Serena, in sec. 20, T. 35 N., R. 5 E. (Mission Twp.). These terraces have a variable cover of gravel and sand which at least locally is as much as 30 feet thick but is usually much thinner and in some places is less than 5 feet thick. Prospecting may reveal large tracts with a thin overburden. The sandstone is probably at least 75 feet thick at the south end of the area but it may not be over 25 feet thick at the north end. The sandstone is all in the lower fine-grained part of the St. Peter formation. The area ranges from one to two miles from the Chicago, Burlington and Quincy Railroad.

The St. Peter sandstone crops out at many other places in Fox Valley bluffs and along the lower parts of the tributary valleys in the northwest part of the Marseilles quadrangle (pl. 1) but at most of them the sandstone has a thin overburden in comparatively small tracts, as the upper 50 to 75 feet of the bluffs consists of glacial drift.

*Area 2, at Wedron.*—The St. Peter sandstone crops out at many places near Wedron in secs. 3, 4, 9, 10, T. 34 N., R. 4 E. (Dayton and Rutland Twps.), Ottawa quadrangle, and is worked by the Wedron Silica Company on the west side of Fox Valley at the mouth of Buck Creek. A small pit was formerly worked at the mouth of Indian Creek, half a mile north of Wedron, at the NW. corner SW. ¼ SW. ¼ sec. 3. The sandstone has a thick overburden at this pit but west of it a considerable part of the valley-floor and terrace along the north side of Indian Creek is underlain by sandstone at a shallow depth. The upper 10 to 15 feet of the sandstone is exposed along the creek. The sandstone is well exposed in the bluffs on the east side of Fox River in the NW. ¼ sec. 10, but the overburden is thick. A possible site for development on the east side of the river is at the mouth of the large ravine southeast of Wedron, in the SE. ¼ sec. 9. The sandstone has a thin overburden in the valley-flat and in low terraces south of the ravine. The sandstone was formerly worked in the bluffs north of the ravine where it has a heavy overburden. The 20-25 feet of sandstone above the level of Fox River at Wedron is all in the upper medium-grained part of the St. Peter formation. The lower fine-grained sandstone is exposed in the lower part of the Wedron Silica Company pit (app. D, table 3, Nos. 18-21). At the north end of the area the top of the fine-grained sand is about 20 feet above Fox River. The chemical composition of the sand is shown by the analysis of a sample from the Wedron Silica Company pit (app. H, table 1, No. 4). Transportation is provided by the Chicago, Burlington and Quincy Railroad which follows the west side of Fox Valley.

*Area 3, south of Wedron.*—The St. Peter sandstone underlies a terrace along the west side of Fox Valley south of Wedron, in secs. 16, 21, T. 34 N., R. 4 E. (Dayton Twp.), Ottawa quadrangle, and the upper 30 feet was formerly worked in the lower part of the ravine in the NW. ¼ sec. 16. The terrace is mostly ⅛ to ¼ mile wide and is about 1½ miles long. The sandstone has a thin overburden of gravel and silt, except at the south end where it is overlain by a few feet of Pennsylvanian strata. Very little of the sandstone has been eroded and it is probably at least 150 feet thick. A sample from the pit was a medium-grained sand of which 55 per cent was coarser than 35-mesh (app. D, table 3, No. 45C). The terrace is crossed by the Chicago, Burlington and Quincy Railroad.

*Area 4, at Dayton.*—The St. Peter sandstone underlies a terrace 100-200 yards wide and ¾ mile long on the east side of Fox Valley at Dayton, in the NE. ¼ sec. 32, SE. ¼ sec. 29, T. 34 N., R. 4 E. (Rutland Twp.), Ottawa quadrangle. The upper 20 to 30 feet of the sandstone exposed along the river has a thin overburden of sand and soil mostly less than 6 feet thick. The sandstone is probably about 150 feet thick. The area is less than one-quarter mile from the Chicago, Burlington and Quincy Railroad on the west side of Fox River.

*Area 5, east of Ottawa.*—The St. Peter sandstone occurs at a shallow depth in a terrace east of Ottawa between Fox and Illinois rivers in sec. 7, T. 33 N., R. 4 E. (Rutland Twp.), secs. 1, 12, T. 33 N., R. 3 E. (Ottawa Twp.), Ottawa quadrangle. The sandstone is probably 140 to 150 feet thick and except near the rivers has an overburden of Pennsylvanian bedrock which consists of shale, coal, and underclay. Part of the area has been stripped to recover these materials and the present overburden on the sandstone is the waste piles of these workings. The overburden is probably 20 feet or more thick east of the central part of sec. 7 except near Illinois River. About 35 feet of the sandstone is worked by the Ottawa Hydraulic Sand Company in a pit on Bulls Island in Illinois River. All but the upper 8 feet of the sand is dredged from below water-level. The sand is shipped in barges. The north part of the area is crossed by the Chicago, Rock Island and Pacific Railroad.

*Area 6, west and southwest of Ottawa.*—The St. Peter sandstone underlies a large terrace on the north side of Illinois River west and southwest of Ottawa in secs. 9, 10, 15, 16, 21, T. 33 N., R. 3 W. (Ottawa Twp.), Ottawa quadrangle. Two washing plants are operated in this area by the Ottawa Silica Company and one by the Standard Silica Company. Another washing plant is idle. Crude sand is produced at one pit by the Aetna Sand and Gravel Company. Two pits were formerly worked for grinding and polishing sand by the National Plate Glass Company, now the Libby-Owens-Ford Glass Company. The sandstone is about 140 feet thick. It generally has only a thin overburden of soil but in some places (pl. 2) it is overlain by limestone usually less than 5 feet thick. The character of the sand in this area is shown by chemical analyses (app. H, table 1, Nos. 5-7) and sieve tests (app. D, table 3, Nos. 1-3, 7, 9, 13, 13a, 23, 24). Although large parts of the terrace are undeveloped, it is probable that the present companies hold as reserves most of the area. A large tract extending along the margin of the terrace between the railroad and the Waterway, in the south part of sec. 16, is undeveloped and is favorably located to use both water and rail transportation. The area is served by the Chicago, Rock Island and Pacific and the Chicago, Burlington and Quincy railroads.

*Area 7, southwest of Ottawa.*—The St. Peter sandstone underlies a narrow terrace extending along the south side of Illinois Valley for about two miles southwest of Ottawa in secs. 14, 15, 21, 22, T. 33 N., R. 3 E. (South Ottawa Twp.), Ottawa quadrangle. Crude sand is produced in this area by the Acme Silica Sand Company and the Bellrose Sand Company. A washing plant was formerly operated in the NW. ¼ SE. ¼ NE. ¼ sec. 15. The undeveloped areas are near the active pits at the ends of the area. Sieve tests of sand from this area are given in appendix D (table 3, Nos. 43, 45). The area is served by the Chicago, Burlington and Quincy Railroad and is adjacent to the Illinois Waterway.

*Area 8, southwest of Ottawa.*—The St. Peter sandstone occurs at a shallow depth in a large terrace along the south side of Illinois Valley, south and southeast of Buffalo Rock, in secs. 19-21, 28-30, T. 33 N., R. 3 E. (South Ottawa Twp.), Ottawa quadrangle. The terrace is about a mile wide at its broadest place and is a little more than three miles long. At the extreme eastern end of the terrace (pl. 2) the sandstone has an overburden of limestone about 10 feet thick. In an elevated area west of the limestone-covered area, largely in the W. ½ sec. 21, the sandstone crops out at many places and generally has only a thin overburden of soil. Farther west the top of the sandstone is somewhat lower and is locally covered with gravel and sand usually less than 10 feet thick. The sandstone is about 140 feet thick in the eastern part of the terrace but thins to about 75 feet at the west end of the area. The sandstone is exposed in the lower part of the bluffs south of the terrace and east of Starved Rock State Park but has a heavy overburden of Pennsylvanian strata and glacial drift. The nearest railroad is the Chicago, Burlington and Quincy Railroad two miles east. The area is along the Illinois Waterway.

*Area 9, Buffalo Rock.*—Buffalo Rock in secs. 17-19, T. 33 N., R. 3 E. (Ottawa

Twp.), Ottawa quadrangle, is composed largely of St. Peter sandstone overlain by 10 to 25 feet of Pennsylvanian strata consisting of clay, coal, and shale. The eastern end of the Rock is in Buffalo Rock State Park. Most of the Rock west of the park has been stripped for coal or clay so that the overburden of the sandstone consists largely of ridges of wastepiles. The sandstone is about 140 feet thick, of which 60 to 75 feet occurs above the level of Illinois River. Much of the sandstone is light yellow, but there are some thick beds of white sand and a few thin beds are stained dark brown with iron oxide. Crude sand was formerly shipped from several pits in the Rock and the character of the sand is shown by tests of samples from these pits (app. D, table 3, Nos. 11, 14, 45b). The Chicago, Rock Island and Pacific Railroad is along the north side of Buffalo Rock and the south side is adjacent to the Illinois Waterway. Sand could be loaded directly to barges on the Waterway.

*Area 10, Twin Bluffs to Higbee Ravine.* Crude sand has been produced at many pits in the St. Peter sandstone in the north bluff of Illinois Valley between Twin Bluffs in the NE. cor. sec. 17, T. 33 N., R. 3 E. (Ottawa Twp.), and Higbee Ravine in center sec. 14, T. 33 N., R. 2 E. (Utica Twp.), Ottawa quadrangle (pl. 5). At present two pits are worked by the American Silica Sand Company and the Illinois Silica Sand Company. The sand in this area is overlain by Pennsylvanian strata and glacial drift. The Pennsylvanian strata are about 40 feet thick near Twin Bluffs but thin westward and are only a few feet thick at the mouth of Higbee Ravine. The glacial drift is commonly 5 to 10 feet thick but gradually increases in thickness back from the bluff. One of the Pennsylvanian beds is the LaSalle (No. 2) coal, which is 1 foot 6 inches to 2 feet thick and can be recovered in stripping operations. The underclay of the coal is usually refractory and has been exploited at a few places. The sandstone is mostly light yellow or white but some bands, especially near the top, have brown limonitic streaks. In general the sand is more discolored in this area and in Buffalo Rock than in any of the other areas. The sand that is mined is mostly the upper medium-grained sand but this member appears to thin toward the west end of the area where it is only about 25 feet thick. The grain size of the sand is shown by samples from several pits (app. D, table 3, Nos. 22, 25, 27, 42). The sandstone is 140 to 150 feet thick and 50 to 80 feet occurs above the level of the Illinois Valley floor. Many of the idle pits could be reopened and there are potential sites for new pits in the bluff. The Chicago, Rock Island and Pacific Railroad at the base of the bluff provides transportation.

*Area 11, Higbee Ravine to Utica.*—In the north bluff of Illinois Valley from Higbee Ravine in the center of sec. 14 to the west margin of the quadrangle at Utica in sec. 9, T. 33 N., R. 2 E. (Utica Twp.), Ottawa quadrangle, washed sand is produced by the American Silica Sand Company and crude sand by the American Silica Sand Company, the Bellrose Sand Company, and George M. Pendergast and Company. The area contains several pits which are now idle. The sandstone has an overburden of glacial drift, mostly till, which is generally less than 10 feet thick at the bluff but is locally 15 feet thick and usually increases in thickness back from the bluff. Some Pennsylvanian strata are locally present back from the bluff near Higbee Ravine. The upper 5 to 20 feet of the sandstone is eroded so that the sandstone is probably 115 to 130 feet thick, of which 75 to 110 feet occurs above the floor of Illinois Valley. The sandstone is somewhat whiter than in the bluffs east of Higbee Ravine but bands of yellow or brown sand are present. The upper, medium-grained sand is only about 25 feet thick at Higbee Ravine but is about 75 feet thick near the west side of the quadrangle. Most of the pits in this area differ from those farther east in being worked in two benches, the separation of the benches being at or near the contact of the medium- and fine-grained sand. The character of the sand is shown by tests of samples from the pits (app. D, table 3, Nos. 28, 29, 32-36, 38-41). Sites for new pits are present and the operating pits have large reserves. Transportation is furnished by the Chicago, Rock Island and Pacific Railroad at the base of the bluff.

Table 12.—References to Published Ceramic Tests and Descriptions of the Samples of the Underclay of LaSalle (No. 2) Coal

| Sample No. | Reference | | Location | | | | | | | | Thickness sampled feet | Collected from | Fusion test P.C.E. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Report[a] | Page | Town (at or near) | ¼ | ¼ | ¼ | sec. | T. | R. | Quadrangle | | | |
| 51 | A | 62, 63 | Seneca | SW | SE | NE | 23 | 33 N | 5 E | Marseilles | 3¾ | Shaft mine, abandoned | |
| 52 | A | 62, 63 | Seneca | SW | SE | NE | 23 | 33 N | 5 E | Marseilles | 2 | Shaft mine, abandoned | |
| 129 | B | 124, 139-140 | Marseilles | NW | SE | NW | 21 | 33 N | 5 E | Marseilles | 8½-11 | Shaft mine, idle | 27-28 |
| W- 28 | C | | Marseilles | SE | NW | SE | 10 | 33 N | 4 E | Marseilles | 1 | Shaft mine, abandoned | 28-29 |
| W- 29 | C | | Marseilles | SE | NW | SE | 10 | 33 N | 4 E | Marseilles | 2 | Shaft mine, abandoned | 28-30 |
| 99 | B | 123, 137-138 | Dayton | SW | NE | NW | 32 | 34 N | 4 E | Ottawa | 4½-5½ | Fox River Clay Works drift mine | 30 |
| 102 | B | 123, 138-139 | Dayton | SW | NE | NW | 32 | 34 N | 4 E | Ottawa | | Outcrop near Fox River Clay Works mine | 27 |
| 101 | B | 123, 136-137 | Ottawa | | NE | NE | 12 | 33 N | 3 E | Ottawa | 4-8 | Chicago Retort and Firebrick Co. pit | 29 |
| 91 | B | 122, 135 | Ottawa | SE | SE | NE | 7 | 33 N | 4 E | Ottawa | 8 | National Fireproofing Co. pit | 27 |
| 92 | B | 122, 136 | Ottawa | SE | SE | NE | 7 | 33 N | 4 E | Ottawa | 5-9 | National Fireproofing Co. pit | 29 |
| 95 | B | 122, 133-134 | Ottawa | | | Cen. | 9 | 33 N | 3 E | Ottawa | 8 | Drift mine, abandoned | 27 |
| 94 | B | 122, 134-135 | Ottawa | NE | NE | NE | 17 | 33 N | 3 E | Ottawa | 7 | National Fireproofing Co. pit | 31 |
| 97 | B | 120, 127-128 | Utica | SE | SW | NE | 21 | 33 N | 2 E | Ottawa | 4 | Streator Brick Co. pit | 28 |
| 98 | B | 120, 129-130 | Utica | SE | SW | NE | 21 | 33 N | 2 E | Ottawa | 4 | Streator Brick Co. pit | 29 |
| 100 | B | 120, 128-129 | Utica | SE | SW | NE | 21 | 33 N | 2 E | Ottawa | 9 | Streator Brick Co. pit | 31 |
| 77 | B | 118, 126 | Utica | | SE | NE | 20 | 33 N | 2 E | LaSalle | 5 | Pit, abandoned | 28 |
| 82 | B | 119, 126-127 | Utica | | SE | NE | 20 | 33 N | 2 E | LaSalle | 5-6 | Pit, abandoned | 26 |
| 87 | B | 118, 125 | Utica | | SE | NE | 20 | 33 N | 2 E | LaSalle | 3½ | Pit, abandoned | 28 |
| 93 | B | 121, 130-131 | Oglesby | NE | NW | SE | 30 | 33 N | 2 E | LaSalle | 13 | Drift mine, abandoned | 29 |
| 96 | B | 121, 131-132 | Oglesby | NE | NW | SE | 30 | 33 N | 2 E | LaSalle | 4 | Drift mine, abandoned | 31 |
| 89 | B | 121, 132-133 | Lowell | | | SW | 9 | 32 N | 2 E | LaSalle | | Outcrop | 26 |
| 90 | B | 121, 132 | Lowell | | NW | SW | 9 | 32 N | 2 E | LaSalle | 12-25 | Conco-Meier Co. pit | 30-31 |
| 131 | B | 124, 140-141 | Kangley | SW | NE | SE | 22 | 31 N | 3 E | Streator | 5 | Shaft mine, abandoned | 25 |
| 130a | B | 124, 140 | Streator | SW | NE | SE | 1 | 30 N | 3 E | Streator | 1⅓-4 | Shaft mine, abandoned | 25 |
| 130b | B | 124, 140 | Streator | SW | NE | SE | 1 | 30 N | 3 E | Streator | 2½ | Shaft mine, abandoned | 25 |

[a]A—Stull, R. T., and Hursh, R. K., Tests of clay materials available in Illinois coal mines: Illinois Geol. Survey Coop. Mining Ser. Bull. 18, 1917.

B—Parmelee, C. W., and Schroyer, R. C., Further investigations of Illinois fireclays: Illinois Geol. Survey Bull. 38, also extract in Bull. 38D, 1921. Page references are to Bull. 38D.

C—This report, Appendix J.

*Area 12, east of Utica.*—The St. Peter sandstone occurs below a variable overburden of sand and gravel in a large part of the terrace north of Illinois River between Buffalo Rock and Utica. The Chicago, Rock Island and Pacific Railroad is located along the north margin of the terrace and the Illinois Waterway is along the south side. This is the only large area where the fine-grained sandstone occurs below a thin overburden along the Waterway. Much of the terrace is swampy and only a few feet above the water-level in the pool above Starved Rock dam. The highest part of the terrace is near the Hager school.

## CLAY AND SHALE

The Marseilles-Ottawa-Streator area contains large deposits of refractory and nonrefractory clays and shales which have long been used in the manufacture of a variety of clay products. Refractory clay is produced from the underclay of LaSalle (No. 2) "Third Vein" coal, and the principal nonrefractory materials which have been used are the Francis Creek shale overlying the LaSalle (No. 2) coal and the shale overlying the Herrin (No. 6) coal. Tests indicate that other beds of shale and clay in the Pennsylvanian strata are also suitable for some uses. The widespread deposits of glacial silt and clay may be used for some ceramic products. Large pockets of clay similar in appearance to the underclay of coal No. 2, and probably also refractory, occur in the St. Peter sandstone and the Platteville limestone but individually they probably do not contain enough clay to be worked on a large scale.

### REFRACTORY CLAY

#### Underclay of LaSalle (No. 2) Coal

The underclay of LaSalle (No. 2) coal occurs at or near the base of the Pennsylvanian strata or "Coal Measures" and consequently is present throughout practically the entire area of Pennsylvanian strata (p. 96 and pl. 11). It rests on the St. Peter sandstone or the Platteville, Decorah, and Galena limestones except in the areas where lower Pennsylvanian beds occur. The clay crops out along the lower four miles of Fox Valley, along Illinois Valley from the mouth of Fox Valley to the west side of the Ottawa quadrangle, and along Vermilion Valley in the southwest corner of the Ottawa quadrangle and the northwest corner of the Streator quadrangle. It is also exposed at several places along the east side of the LaSalle quadrangle west of the Ottawa quadrangle. Elsewhere the depth to the top of the clay may be estimated from the map showing the elevation of the top of the LaSalle (No. 2) coal (pl. 12) and the topographic maps showing the elevation of the ground surface (pls. 4-6).

##### CHARACTER

Throughout most of the area the clay is less than 6 feet thick, is gray and sandy, and locally contains lenses of clayey sandstone. Where more than 8 feet thick the clay commonly is separable into three units, an upper gray clay 3-9 feet thick, a middle green clay 2 inches to 3 feet thick, and a lower gray clay 5-14 feet thick. Locally the three units total as much as 20 feet thick. Chemical analyses (app. H, table 1, Nos. 206, 211, W-28, W-29) show the clay contains less iron oxide, magnesia, and alkalies than the other Pennsylvanian clays and shales. The character of the clay is described in detail in the chapter on stratigraphy (p. 96).

##### CERAMIC PROPERTIES

Many tests (table 12) show that the underclay of coal No. 2 is generally refractory in the area where it crops out and also in mines near Marseilles (app. J, W-28, W-29). Samples from mines at Seneca, Kangley, and Streator were not refractory. The green clay is not refractory. A few samples of the gray clay from outcrops were nonrefractory but in these cases samples from nearby pits where the material was freshly exposed were refractory and the weathered clay may contain fluxing materials which are not present in the fresh clay. Most of the samples burned light gray or cream below a temperature ranging from cone four to cone nine and buff or brown at higher temperatures. A few samples burned buff or brown in the entire range tested.

FIG. 113.—Strip-mining the underclay of LaSalle (No. 2) coal in the pit of the Chicago Retort and Firebrick Company, east of Ottawa, NW. ¼ SW. ¼ sec. 5, T. 35 N., R. 4 E. (Rutland Twp.), Ottawa quadrangle. The coal overlying the clay is also recovered but the Francis Creek shale above the coal is discarded.

FIG. 114.—LaSalle (No. 2) coal and underclay in the pit of the Chicago Retort and Firebrick Company, east of Ottawa, NW. ¼ SW. ¼ sec. 5, T. 33 N., R. 4 E. (Rutland Twp.), Ottawa quadrangle. The hammer head is at the top of the clay.

USES

The clay has been used in the manufacture of fire brick, face brick, pottery, condensers, and retorts, in lining furnaces, and for various purposes in foundries and steel and zinc mills. It is probably suitable for other uses of plastic refractory clays, especially in mixtures with the highly refractory flint clays. Finely divided pyrite, which gives burned products a speckled appearance is present in the clay at many localities and limits its usefulness for some products, such as terra cotta.

INDUSTRY

The refractory clay is the source of an important industry which manufactures a variety of refractory and structural clay products and produces ground and raw clay.

The Chicago Retort and Firebrick Company has worked from 6 to 9 feet of clay in a large area along the south and east side of Fox River, east of Ottawa, and the present pit is in the NW. ¼ SW. ¼ sec. 5, T. 33 N., R. 4 E. (Rutland Twp.), Ottawa quadrangle (figs. 113, 114). The plant is located in the NE. ¼ NE. ¼ sec. 12, T. 33 N., R. 3 E. (Ottawa Twp.), Ottawa quadrangle. The company operates 22 kilns and produces regular and super-duty fire clay brick and shapes, fire clay ladle brick and shapes, plastic and castable refractories, and refractory cement. In the manufacture of many products the local clay is mixed with flint clay.

The Streator Brick Company operates the Gorman pit near Starved Rock in the SW. ¼ NE. ¼ NE. ¼ sec. 21, T. 33 N., R. 2 E. (Deer Park Twp.), Ottawa quadrangle. The clay is used at Streator in the manufacture of face brick. It is 10-18 feet thick.

The Fox River Clay Works produces clay from a pit on the east side of Fox Valley at Dayton, in the NE. ¼ SE. ¼ sec. 29, T. 34 N., R. 4 E. (Rutland Twp.), Ottawa quadrangle. The clay is ground at the plant half a mile south of Dayton, in the NW. ¼ SE. ¼ NW. ¼ sec. 32, T. 34 N., R. 4 E. (Dayton Twp.). The Francis Creek shale overlying the coal has been worked in a pit at the plant and mixed with the clay for some uses. The clay was formerly mined near the plant and it has also been obtained from the same bed where it occurs in the overburden of a silica-sand pit north of Buffalo Rock. The company produces fire clay, foundry clay, plastic shale, and bonding clay.

The pit of the Conco-Meier Company at Lowell is largely in the LaSalle quadrangle but extends into the southwest corner of the Ottawa quadrangle. The clay is mostly 12-15 feet thick. The plant, with 19 kilns, is in the SW. ¼ SW. ¼ sec. 9, T. 32 N., R. 2 E. (Vermilion Twp.), LaSalle quadrangle. At present only face brick is produced but formerly fire brick was also produced. Recently most of the clay used has been taken from a pit southwest of Starved Rock, about a quarter of a mile west of the Ottawa quadrangle, in the NW. ¼ SW. ¼ sec. 21, T. 33 N., R. 2 E. (Deer Park Twp.), LaSalle quadrangle.

The Silver Clay and Coal Company has produced clay at a shaft mine (Spicer Mine) two miles east of Marseilles, in NE. ¼ SE. ¼ NW. ¼ sec. 21, T. 33 N., R. 5 E. (Manlius Twp.), Marseilles quadrangle, but the mine is now idle. It was formerly operated by the Chicago Firebrick Company. The clay is 6-15 feet thick and 95 feet deep. The clay was ground.

The Herrick Clay Manufacturing Company formerly worked 8 feet of clay in a drift mine in the north bluff of Illinois Valley, west of Ottawa, near the center of sec. 9, T. 33 N., R. 3 E. (Ottawa Twp.), Ottawa quadrangle, and 3 to 6 feet of clay in an open pit on the north side of Buffalo Rock in the SE. ¼ NE. ¼ SE. ¼ sec. 18, T. 33 N., R. 3 E. (Ottawa Twp.). Ground clay was produced.

The National Fireproofing Company formerly worked 10-20 feet of clay in the Pioneer pit east of Ottawa, in the NW. ¼ SE. ¼ sec. 7, T. 33 N., R. 3 E. (Rutland Twp.), Ottawa quadrangle, and 7 feet of clay in a pit at Twin Bluffs, west of Ottawa.

The clay was formerly also used in Lowell in the manufacture of pottery.

### RESOURCES

The undeveloped resources of refractory clay in the area are undoubtedly very large, although much of them occurs below a thick overburden and can be recovered only by shaft mining. Considerable quantities of clay can be produced by strip mining in the general vicinity of the present operations and probably elsewhere near the outcrop of the coal (pl. 12), although at many places along the outcrop-line the clay has an overburden of bedrock or of glacial drift too thick to be removed by stripping. The most favorable areas for prospecting for clay are briefly described below.

*North bluff of Illinois Valley west of Ottawa.*—From Ottawa to Twin Bluffs the clay occurs in the north bluff of Illinois Valley below an overburden of shale and glacial drift too thick to be stripped, although it rises from the base of the bluffs at Ottawa to the middle of the bluff at Twin Bluffs. It was formerly worked by a drift mine near the center of sec. 9, T. 33 N., R. 3 E. (Ottawa Twp.), Ottawa quadrangle, and was 8 feet thick.

From Twin Bluffs west to the mouth of Higbee Ravine the clay is exposed in the upper part of the bluff and may be stripped at several places. The clay is mostly very sandy in this area and is commonly 3-6 feet thick although at Twin Bluffs it is 7 feet thick and locally near Buffalo Rock it is only 1 foot thick. The clay has an overburden 30-35 feet thick at the shale pit of the National Fireproofing Company at Twin Bluffs. However, the upper 20 feet of shale has been stripped in a large area and the clay has an overburden of only 10 feet of shale and 2 feet of coal. The overburden generally decreases west of Twin Bluffs, as the top of the clay rises in that direction 10-15 feet per mile, and at Higbee Ravine the clay is at the top of the bluff. The clay is exposed in the overburden of pits in the St. Peter sandstone and a small quantity of clay has been locally recovered in the stripping operations. As the coal is commonly recovered, the clay could also be salvaged with little additional expense, although the production would not be large at the present rate of expansion of the sand pits.

West of Higbee Ravine the clay is not exposed but occurs below part of the upland area back from the bluff. Prospecting might reveal workable deposits beneath a thin overburden, but the clay may be too thin to be worked at many places.

Transportation is available by the Chicago, Rock Island and Pacific Railroad along the base of the bluffs.

*Buffalo Rock.*—The clay underlies nearly all of Buffalo Rock at a depth of 10 to 25 feet, is commonly 3-5 feet thick but has a maximum thickness of about 6 feet, and is locally very thin or absent. The clay is sandy and locally contains thin lenses of sandstone. It was formerly mined and ground in the SE. ¼ NE. ¼ SE. ¼ sec. 18, T. 33 N., R. 3 E. (Ottawa Twp.), Ottawa quadrangle. West of Buffalo Rock State Park, which occupies only the east end of the Rock, most of the area has been stripped for coal and although the clay is generally present it is covered by an overburden of waste material from the coal-mining operation. The absence of the coal detracts from the desirability of the area, although the possibility of direct loading of clay to barges on the waterway along the south side of Buffalo Rock might favor the locality. A switch of the Chicago, Rock Island and Pacific Railroad is along the north side of Buffalo Rock.

*South bluff of Illinois Valley west of Ottawa.*—The clay occurs in the south bluff of Illinois Valley west of Ottawa to the east end of Starved Rock State Park but has a thick overburden. It could be worked by drift mining although in part of the area it may be too thin. The clay is locally shallow enough to strip near the west boundary of the quadrangle and south of the park. It is mined by the Streator Brick Company in the SE. ¼ NE. ¼ sec. 21, T. 33 N., R. 2 E. (Deer Park Twp.), Ottawa quadrangle, and used at Streator in the manufacture of face brick. The clay may also be strippable south of the park in the SE. ¼ sec. 21 and in the SW. ¼ sec. 22 between French and Wildcat canyons. Transportation is available by the Chicago, Burlington and Quincy Railroad at the east end of the area, and the remainder of the area is near State Highway No. 71.

*Floor of Illinois Valley east of Ottawa.*—The underclay has an overburden generally less than 20 feet thick in most of the floor of Illinois Valley for about two miles east of Ottawa and in a narrow area near Illinois River for about a mile farther. The clay has a thicker overburden farther east because in that direction it dips down 10-15 feet per mile. The clay can possibly be worked on both sides of Illinois River in secs. 7, 8, 17, and 18, T. 33 N., R. 4 E. (Rutland and Ottawa Twps.), Ottawa quadrangle, but the coal has been stripped in part of that area.

The clay may also be strippable northeast of Ottawa and north and west of Fox River, mostly in the NE. ¼ sec. 1, T. 33 N., R. 3 E., and sec. 6, T. 33 N., R. 4 E. (Ottawa Twp.), Ottawa quadrangle. The clay is not exposed, but a short distance south it is 5-10 feet thick. The overburden is probably 10-15 feet thick in the south part of the area but is probably 25-35 feet thick at the north.

Transportation is provided by the Chicago, Rock Island and Pacific and the Chicago, Burlington and Quincy railroads and the Illinois Waterway.

*Fox Valley.*—The clay crops out near the base of the bluffs along Fox Valley from Illinois Valley to one mile south of Sulphur Springs. The areas in the valley-flat where the clay can be stripped are small, but the clay could be worked by drift mines in the valley or by shaft mines on the upland. Near the north end of this area the clay is locally only 6 inches thick, but in the vicinity of Dayton it is 4-6 feet thick and is worked in a pit near the east end of the Dayton dam. It was formerly worked by drift and shaft mines half a mile southwest of Dayton. The Chicago, Burlington and Quincy Railroad follows the west side of the valley.

*Covel Creek.*—The clay can probably be stripped in the valley of Covel Creek two miles southwest of Ottawa, although the area is relatively inaccessible. Where exposed in a bank along the west side of the stream at the center of the SE. ¼ NW. ¼ sec. 27, T. 33 N., R. 3 E. (South Ottawa Twp.), Ottawa quadrangle, the clay is at least 9 feet thick and is probably about 12 feet thick. The clay is noncalcareous but locally contains lenses and spheroidal masses of limestone as much as 1 foot thick about 5 feet below the top. Although the valley-bottom is only about 150 yards wide for a quarter of a mile upstream from the outcrop, it broadens to nearly a quarter of a mile wide in the SE. ¼ NE. ¼ sec. 27. In the broader area there is a low terrace below which the clay is probably 5 to 10 feet deep on the west side and 15 to 20 feet deep on the east side. The road nearest to this area is about a mile up the valley. The Chicago, Burlington and Quincy Railroad is on the upland half a mile northeast of the eastern end of the area.

*Vermilion Valley.*—Near Lowell the underclay of coal No. 2 occurs below a thin overburden in the terrace along the south side of Vermilion River in the southwest corner of the Ottawa quadrangle and the northwest corner of the Streator quadrangle, adjacent to the pit of the Conco-Meier Company. The clay is locally as much as 20 feet thick but is more commonly 10-15 feet thick. It could possibly be stripped in a terrace 50-100 yards wide and about a quarter of a mile long on the east side of the Vermilion Valley along the west side of the NW. ¼ NW. ¼ sec. 15, T. 32 N., R. 2 E. (Deer Park Twp.), Streator quadrangle, and also in an adjoining area in the floor of a tributary valley largely in the N. ½ NW. ¼ sec. 15, in the Streator and Ottawa quadrangles, at the mouth of which it is poorly exposed. It may also be strippable in a slightly larger terrace on the west side of Vermilion Valley extending from the center of the west line to the center of the south line of sec. 15. The clay could be worked elsewhere in this vicinity by drift or shaft mines. The Chicago, Burlington and Quincy Railroad is at Lowell.

*Other areas.*—The clay could be worked by shaft mines at many other places. As previously noted, samples of the clay from coal mines at Seneca, Kangley, and Streator were nonrefractory. Test-drilling and testing of samples is necessary to demonstrate the presence of workable deposits where the clay is deeply buried. The most favorable areas for prospecting occur near those places where the thick refractory clays have been worked, as at Ottawa, south of Starved Rock, and Lowell. From the viewpoint of transportation, the most favorable areas are along Illinois Valley between Ottawa and Seneca where both rail and water transportation are available, and along the Chicago, Burlington and Quincy Railroad northeast of Ottawa at least as far as Dayton, south of Ottawa in the Ottawa quadrangle, and near Lowell.

### Other Refractory Clays

The clay which occurs in pockets in the St. Peter sandstone (p. 78) and as cave-fillings in the Platteville limestone (p. 81) appears much like the underclay of the LaSalle (No. 2) coal and may be its equivalent. The clay is probably refractory but has not been tested. It is doubtful if any of these deposits are large enough to be worked on a commercial scale but it is possible that the clay in the large pockets which are excavated or worked around in the silica-sand pits could be used.

## NONREFRACTORY CLAY AND SHALE

Many beds of nonrefractory clay and shale occur in the Pennsylvanian strata and several have been extensively developed in the vicinity of Ottawa and Streator. Glacial deposits of clay and silt are also common but are not used for ceramic products, as they are generally less desirable than the clays and shales of the Pennsylvanian system.

### Francis Creek Shale

The Francis Creek shale (p. 100), which overlies the LaSalle (No. 2) "Third Vein" coal and is the roof shale in the mines, comprises a large part of the material in the waste piles at underground mines using the longwall method of mining and is usually the most abundant material in the waste piles of the strip mines. In the Ottawa quadrangle the shale is exposed at many places in the bluffs of Illinois Valley and the tributary valleys west of Ottawa, in the bottom of Illinois Valley east of Ottawa for about three miles, in the lower four miles of Fox Valley, and along Vermilion Valley in the southwest corner of the quadrangle. In the Streator quadrangle the shale is exposed along the lower mile of Vermilion Valley. Elsewhere the shale is buried by higher bedrock strata or by glacial drift.

CHARACTER

The shale is commonly 20 to 30 feet but ranges from 10 to 50 feet thick, is medium to dark gray, occurs in beds ¼ to 3 inches thick, and contains gray ironstone concretions and crystals of pyrite, especially in the lower 5 to 10 feet. The upper part of the shale is sandy. Comparison of chemical analyses of the shale (app. H, table 1, W-18, W-27, W-79) with analyses of the -2 micron fraction of the shale (app. H, table 1, Nos. 36, 204, 288) shows that removal of the silt- and sand-sized grains takes out much of the pyrite, as the iron oxide is reduced and the alumina is increased.

FIG. 115.—Shale-planer excavating the Francis Creek shale in pit of the National Fireproofing Company, east of Ottawa, SW. ¼ NE. ¼ NE. ¼ sec. 7, T. 33 N., R. 4 E. (Rutland Twp.), Ottawa quadrangle. This pit is now abandoned but the same company has a similar operation at Twin Bluffs west of Ottawa.

CERAMIC PROPERTIES

Samples of the shale from pits half a mile southwest of Dayton and at Buffalo Rock and from the shaft of a mine two miles west of Marseilles (app. J, W-18, W-27, W-79) burned red to chocolate-brown and had a well-vitrified body between cone 02 and cone 3. All were overburned at cone 6. Samples collected from a mine at Seneca,[6] and representing only the lower few feet of the shale where the impurities are high, had a maximum safe burning temperature of cone 02 and cone 04. A sample of the shale from a shaft at Wenona,[7] a short distance west of the Streator quadrangle, had a maximum safe burning temperature above cone 3.

USES

The shale has been used principally in the manufacture of hollow building-tile. The ceramic tests indicate the shale is suitable also for common and sewer brick, bloated aggregate, and, if the soluble salts can be controlled, for face brick and tile.

INDUSTRY

The National Fireproofing Company uses the Francis Creek shale in the manufacture of structural and facing tile and other structural products at Twin Bluffs, two miles west of Ottawa, near the NE. cor. sec. 17, T. 33 N., R. 3 E. (Ottawa Twp.), Ottawa quadrangle. The ware is burned in 8 kilns. The shale is mined by a shale-planer (fig. 115) which makes a uniform cut through 15 to 20 feet of shale. No overburden is removed because the few inches of soil overlying the shale comprises such a small proportion of the material mined and is so thoroughly mixed by this mining procedure that it is not detrimental to the manufactured products. The lower 10 feet of shale is not used because it contains so many pyrite, gypsum, calcite, and ironstone concretions. The same company formerly operated a pit, known as the Pioneer pit, 1½ miles east of Ottawa in the center of sec. 7, T. 33 N., R. 4 E. (Rutland Twp.), and burned hollow building-tile in 12 kilns in Ottawa in the SW. ¼ NW. ¼ SE. ¼ sec. 11, T. 33 N., R. 3 E. (Ottawa Twp.).

The Fox River Clay Works mines shale at a pit southwest of Dayton, in the NW. ¼ SE. ¼ NW. ¼ sec. 32, T. 34 N., R. 4 E. (Dayton Twp.), and uses it principally in mixtures with the underclay of LaSalle (No. 2) coal (p. 244).

RESOURCES

*North bluff of Illinois Valley west of Ottawa.*—The Francis Creek shale is the uppermost bedrock in the north bluff of Illinois Valley west of Ottawa, between Higbee Ravine and the central part of

[6]Stull, R. T., and Hursh, R. K., Tests of clay materials available in Illinois coal mines: Illinois Geol. Survey Coal Min. Inv. Series Bull. 18, samples 42, 48, pp. 60-62, 1917.

[7]Stull, R. T., and Hursh, R. K., op. cit., sample 15, pp. 68, 69.

sec. 9, T. 33 N., R. 3 E. (Ottawa Twp.), Ottawa quadrangle. Farther west it has been eroded and to the east it is overlain by other bedrock. The shale is probably too thin for extensive development immediately along the bluff for a mile or two east of Higbee Ravine, but it increases in thickness back from the exposures in the bluff. The shale generally has a thin overburden of soil and locally a few feet of till. The Chicago, Rock Island and Pacific Railroad follows the base of the bluff.

*Northeast of Ottawa.*—The Francis Creek shale underlies a large terrace in Illinois Valley, 1 mile northeast of Ottawa, mostly in the NW. ¼ sec. 6, T. 33 N., R. 4 E. (Ottawa Twp.), Ottawa quadrangle. The shale is probably 20-30 feet thick and has a thin overburden of soil in part of the area, although a few feet of gravel is locally present, especially in the south part of the terrace near the center of sec. 6. The area is crossed by the Chicago, Burlington and Quincy Railroad.

*East of Ottawa.*—The Francis Creek shale underlies a large area in the floor of Illinois Valley east of the mouth of Fox Valley in secs. 5, 7, 8, 17, 18, and a considerable part of secs. 9 and 16, T. 33 N., R. 4 E. (Rutland and Fall River Twps.), Ottawa quadrangle. The shale is 20-40 feet thick and has an overburden of soil, peat, sand, and gravel usually less than 5 feet thick but locally as much as 10 feet thick. In part of the area near Illinois River the shale has been stripped to recover the underlying coal. The waste piles consist largely of the shale. The area is along the Illinois Waterway, and the Chicago, Rock Island and Pacific Railroad crosses the area north of the river.

*Other areas.*—The Francis Creek shale generally has a thick overburden of other bedrock strata and could be worked only by underground mines at outcrops south of Sulphur Springs, in the south bluff of Illinois Valley west of Ottawa, along Covel Creek, and along Vermilion River near Lowell.

### Underclay of Summum (No. 4) coal

The underclay of Summum (No. 4) coal (p. 110) is commonly about 5 feet thick but ranges from 2 to 8 feet thick and is mostly calcareous. A sample representing the upper 3½ feet of the clay exposed along the Illinois Waterway canal at the Marseilles bridge burned gray at cone 01 and overburned at cone 2 (app. J, W-3). It was reported to be suitable for common or face brick, quarry tile, or crude products. As the clay has a thin overburden in no large tract and as the area in which it occurs contains other thicker beds which are suitable for the same products, it does not appear to be a particularly important resource.

### Canton Shale

The Canton shale has not been used in the Marseilles-Ottawa-Streator area. The shale is locally as much as 60 feet thick but at many places the upper part has been eroded and it is only 5 to 10 feet thick. The shale is well exposed in the north bluff of Illinois Valley between Marseilles and Ottawa and south of Ottawa along Covel Creek. Its character is described in detail elsewhere (p. 121).

#### Ceramic properties

A sample representing 58 feet of Canton shale exposed along Walbridge Creek, two miles west of Marseilles, NW. ¼ SW. ¼ SE. ¼ sec. 11, T. 33 N., R. 4 E. (Rutland Twp.), Marseilles quadrangle, burned red from cone 03 to cone 3 and overburned at cone 4 (app. J, W-1). The shale has satisfactory working properties and drying conduct, and oxidizes easily at low temperatures.

#### Uses

The sample tested was reported to be satisfactory for the manufacture of face brick, drain tile, roofing tile, and quarry tile. The shale appears to be uniform in character and is probably satisfactory for these uses at many other places. The lower 3 to 10 feet of the shale contains several bands of ironstone and limestone concretions and is probably not usable.

#### Resources

*West of Marseilles.*—A favorable locality for the development of the Canton shale is in the north bluff of Illinois

Valley west of Marseilles, near Walbridge Creek. For about half a mile east and one mile west of the creek the shale forms a large part of the bluff and is at least 50 feet thick. Till is present at the top of the bluff and would probably increase in thickness back from the outcrops. The amount of shale below a thin overburden is uncertain, although the overburden may be thin enough to strip along the lower part of Walbridge Creek where erosion has greatly reduced the thickness of the till. The Chicago, Rock Island and Pacific Railroad is a little over a quarter of a mile south of the outcrops in the bluff.

*South of Ottawa.*—The Canton shale is 20 to 40 feet thick along Covel Creek south of Ottawa, especially between the center of sec. 26 and the center of the south line of sec. 25, T. 33 N., R. 3 E. (South Ottawa Twp.), Ottawa quadrangle. The upper part of the shale is more sandy than usual and contains a few thin beds of clayey sandstone. The shale is well exposed at several places near the Chicago, Burlington and Quincy Railroad.

The shale is about 30 feet thick along a tributary to Covel Creek in the SW. ¼ sec. 27 and the SE. ¼ sec. 28, and is 25 to 30 feet thick in the NE. ¼ SW. ¼ sec. 28, but at both localities the area with an overburden less than 10 feet thick is not large. Both areas are more than two miles from a railroad.

*Northwest of Streator.*—The Canton shale is exposed at many places in the Streator quadrangle along Vermilion River below Klein Bridge but is usually only 10-15 feet thick, has a thin overburden only in small tracts, and all of the areas are more than a mile from a railroad.

### Vermilionville Sandstone

The Vermilionville sandstone in some areas contains a considerable thickness of argillaceous strata varying from sandy siltstone to sandy shale. The upper shaly part of the sandstone has been used with the underclay and the roof shale of Herrin (No. 6) coal in the manufacture of brick by the Purington Paving Brick Company south of Streator.

### Underclay of Herrin (No. 6) Coal

The underclay of Herrin (No. 6) coal (p. 129) is exposed at several places along Vermilion River between Klein Bridge and the waterworks dam above Streator, in the Streator quadrangle. The clay is usually 3-5 feet but locally is 12 feet thick; in some areas it is absent. The clay has been used in mixtures with the shale overlying the coal in the manufacture of brick by the Purington Paving Brick Company south of Streator. The clay has a thin overburden only in small areas and probably can be worked only in conjunction with the overlying coal and shale.

### Shale Over Herrin (No. 6) Coal

The shale overlying the Herrin (No. 6) coal (p. 132) is used extensively at Streator in the manufacture of clay products. It crops out at many places along Vermilion River from near the northwest corner of Streator to about a mile above the waterworks dam southeast of Streator, and locally near Klein Bridge. It is locally as much as 60 feet thick but is more commonly 20 to 40 feet thick. The shale is very silty and sandy and at most places contains thin beds of very fine-grained sandstone. Chemical analyses of the shale (app. H, table 1, Nos. 202, K-7, K-15) show it is higher in silica and lower in alumina than other shales in the area.

#### CERAMIC PROPERTIES

Ceramic tests of samples (app. J, 25, K-15) from one pit indicate that the shale has fair plasticity, good molding and drying properties, and burns dark red at cone 3. At another pit the shale is reported to have poor plasticity, a total linear shrinkage of 8 per cent at a burning temperature of 1900-1950° F., and a fusion point of 2000° F.

#### USES

The shale has been used in the manufacture of paving, face, common, and sewer brick, drain tile, hollow building-tile, wall coping, flue lining, segment sewer-block, and clay stove-pipe. In the manufacture of some of these products, fire-clay is mixed with the shale.

INDUSTRY

The shale is used by four companies which have pits near Vermilion River southwest and south of Streator. The operations are briefly described below:

The Purington Paving Brick Company operates a plant one mile south of Streator, on the north side of Vermilion River, in the SE. ¼ SW. ¼ sec. 1, T. 30 N., R. 3 E. (Reading Twp.), Streator quadrangle. Face, paving, and building brick and facing block are produced from 16 rectangular kilns. Ten other rectangular kilns are not now used. The pit is located a short distance southeast of the plant on the south side of Vermilion River. An overburden of 10 to 13 feet of till is stripped and 30 feet of shale is worked. The coal underlying the shale is also recovered and is used at the plant. Recently the pit has been deepened and 1-5 feet of the underclay and 10-15 feet of sandy shale below the coal have been used. This sandy shale is part of the Vermilionville sandstone.

The Streator Brick Company produces common, face, and floor brick and facing block in two tunnel kilns at a plant in the southwest part of Streator, in the NE. ¼ SW. ¼ SE. ¼ sec. 35, T. 31 N., R. 3 E. (Bruce Twp.). Fourteen round kilns are not now used. The pit is immediately north of the plant and 10 feet of glacial drift is stripped to recover 25 feet of shale. The underclay of coal No. 2, mined near Starved Rock (p. 244), is also used.

The Streator Clay Products Company, formerly the Streator Clay Manufacturing Company, produces paving, face, and common brick from a continuous kiln of 30 chambers at a plant about one mile southeast of Streator in the SW. ¼ SW. ¼ SW. ¼ sec. 6, T. 30 N., R. 4 E. (Newtown Twp.). The pit is in the NW. ¼ sec. 7, where 12 to 25 feet of till and sandstone is stripped and 25 to 30 feet of shale is used (fig. 116). The underclay of Sparland (No. 7) coal (p. 252) was formerly mined about a mile south of the shale pit and mixed with the shale.

The Streator Drain Tile Company produces sewer pipe, drain tile, structural tile, flue lining, and wall coping from 17 kilns at a plant in the SE. ¼ NE. ¼ SW. ¼ sec. 35, T. 31 N., R 3 E. (Bruce Twp.). The pit is about a mile south of the plant, on the west bank of Vermilion River, in the SE. ¼ SW. ¼ NW. ¼ sec. 2, T. 30 N., R. 3 E. (Reading Twp.). An overburden of 10 to 15 feet of glacial drift is stripped and 30 to 40 feet of shale is used.

Fig. 116.—Pit of the Streator Clay Products Company, in the shale overlying the Herrin (No. 6) coal, southeast of Streator, SW. ¼ NW. ¼ NW. ¼ sec. 7, T. 30 N., R. 4 E. (Newtown Twp.), Streator quadrangle.

The Streator Drain Tile Company has recently purchased the plant, much of which was destroyed by fire several years ago, formerly operated by the Streator Clay Manufacturing Company in the NE. ¼ SE. ¼ sec. 1, T. 30 N., R. 3 E. (Reading Twp.). Sewer brick, wall coping, flue lining, segment sewer block, and clay stove-pipe were produced from 30 kilns at this plant.

RESOURCES

Large reserves of shale occur adjacent to the present pits and additional deposits favorable for development also occur in the same general area. Because of the lenticular character of the sandstone which overlies the shale south of Streator, locally replacing a large part of the siltstone, the undeveloped deposits should be drilled and samples tested to determine their quality. The area is served by the Wabash, the Atchison, Topeka and Santa Fe, the Alton, the New York Central, and the Chicago, Burlington and Quincy railroads, and almost all of the area in which the shale crops out is within a mile of some railroad.

### Underclay of Sparland (No. 7) Coal

The underclay of Sparland (No. 7) coal (p. 137) is exposed at several places along Vermilion River south of the Streator waterworks dam. It is 10 to 12 feet thick where formerly mined by the Streator Clay Manufacturing Company in the NW. ¼ NW. ¼ NE. ¼ sec. 18, T. 30 N., R. 4 E. (Newtown Twp.), Streator quadrangle, for use with shale in the manufacture of brick and sewer pipe. A sample (app. J, 205) representing 6 feet of the clay in this pit burned cream-colored at cones 02 and 1 and light gray and buff-gray at cones 8 and 10. It fused at cone 20. A test of the clay, reported by the Streator Clay Manufacturing Company, shows very good plasticity, total linear shrinkage of 12.5 per cent at a burning temperature of 2,000-2,050° F., and a fusion point of 2,700° F. The same clay has been mined by the Matthiessen and Hegler Zinc Company at LaSalle for use in the manufacture of zinc condensers, for which purpose the high plasticity of the clay makes it especially desirable.

The clay is exposed along the east side of Vermilion River north of the pit and along the west side of the river a short distance. A boring on the terrace along the west side of Vermilion River northwest of the pit is reported to have penetrated 8 feet of clay below 2 feet of coal, the top of which was at a depth of 18 feet (app. B, 32). A few outcrops also occur along Vermilion River near the south boundary of the Streator quadrangle.

The clay may be shallow enough to be stripped in part of the upland area west of Vermilion River, especially in secs. 10-15, T. 30 N., R. 3 E. (Reading Twp.). The depth and thickness of the coal overlying the clay in this area is given elsewhere (p. 262 and fig. 119).

A test-pit along Moon Creek near the southeast corner sec. 10, T. 30 N., R. 3 E. (Reading Twp.), is reported to have penetrated 10 feet of clay below 2 feet of coal, the top of which was at a depth of 7 feet (app. B, 38).

### Glacial Till

Almost all of the uplands in the Marseilles-Ottawa-Streator area are underlain by glacial till that is largely a calcareous silty clay or clayey silt containing a variable quantity of sand grains, pebbles, and boulders. Similar material has been used elsewhere for the manufacture of common brick and drain and structural tile. The till could be worked at many places along all the railroads in the area and near every city and village.

### Glacial Silt and Clay

A 2- to 3-foot bed of pebble-free, noncalcareous silt is widespread over the uplands beneath the 1 to 1½ feet of black or dark gray soil. Similar material is used elsewhere in the manufacture of common brick and drain tile but it is probably not thick enough in this area to be used.

Beds of calcareous silt and clay, free from pebbles, are common in the glacial drift at many places (pp. 157-159), and some of them may be suitable for the manufacture of some types of clay products. They are rarely more than 10 feet thick and commonly have a thick overburden.

## COAL[8]

One or more workable coals underlie nearly all of the Streator quadrangle and the southern half of the Marseilles and Ottawa quadrangles (fig. 117). The area contains large reserves of coal which are sufficient to supply the local needs for many years. It is probable that most of the remaining coal is in beds less than 3 feet thick and, except for coal under shallow cover which can be recovered by strip mining, extensive developments are likely to await exhaustion of the thicker com-

[8]See also: Cady, G. H., Coal resources of District I (Longwall): Illinois Geol. Survey Coop. Mining Inv. Ser. Bull. 10, 1915.

peting coals of southern Illinois. Along Illinois Valley the LaSalle (No. 2) coal, commonly called the "Third Vein" coal, is worked by a number of mines from which coal is trucked to Ottawa, Marseilles, and other cities principally to the north and east, and recently one mine has shipped by rail. Near Streator the Herrin (No. 6) coal, locally called the Streator coal, is the principal source of coal for local uses. Coals Nos. 4 and 7 and a lenticular coal below coal No. 6 have been worked for local use.

All the coals in the area are classified as high-volatile C bituminous coals.[9] They are of lower rank than the high-volatile B coals of southern Illinois but are of the same general rank as the coals in central and western Illinois.

### Production

The discovery of coal in the Marseilles-Ottawa-Streator area, and perhaps the first in North America, was made during the latter part of the 17th century by French explorers. However, the production of coal did not begin until the permanent settlement of the area in the early part of the 19th century, when the early settlers found the easily accessible coal near the outcrops a convenient and cheap source of fuel. The production of coal long remained a relatively minor industry, and in the middle part of the 19th century the amount of coal shipped on the Illinois and Michigan canal was exceeded many times by the amount of cordwood.

Expansion of the coal industry accompanied the great growth of railroads between 1850 and 1860. Large-scale production in the Streator area started about 1865 and reached its peak in 1890-1900. The industry was active at Streator until most of the thicker portion of the No. 6 coal bed was mined. The last shipping mine was closed in 1915. Mines in the thinner coal beds of the area were not able to compete with the southern Illinois mines which operated in thick seams of higher grade coal. In the last few years the production of the area has increased with growth of a strip-mining industry in coal No. 2 along Illinois Valley. However, the strippable coal will probably be mostly worked out in a few years unless new deposits are discovered or economic conditions favor stripping coal having a thicker overburden.

[9]Cady, G. H., Classification and selection of Illinois coals: Illinois Geol. Survey Bull. 62, p. 33, 1935.

### LaSalle (No. 2) Coal

The LaSalle (No. 2) coal occurs a few feet above the base of the Pennsylvanian or "Coal Measures" strata and consequently underlies nearly all the area in which Pennsylvanian beds are present (pl. 11 and fig. 117). It is equivalent to the lowest of the three workable coals at LaSalle, which accounts for its local designation as the "Third Vein" coal. The coal has a shale roof and a clay floor, both of which have been used in the manufacture of clay products. The coal is commonly recovered in mining either the clay or shale, and locally all three—shale, coal, and clay—have been produced from one pit.

#### character

The coal probably averages a little more than 2 feet thick, although in some parts of the Marseilles-Ottawa-Streator area it is about 3 feet thick and in others it is only a few inches thick. It contains fewer bedded impurities than other coals in the area, although in strip mines near Ottawa the lower inch or two of the coal is impregnated with gypsum and pyrite. Pyrite ("sulphur") occurs in nodules and in scattered crystals along joints and bedding-planes and is especially common in the area between Ottawa and Utica. The distribution, thickness, and character of the coal are described in detail in the chapter on stratigraphy (p. 99).

Analyses of face samples of coal No. 2 (app. H, table 2) show that in a mine west of Ottawa the coal has a rank index of 127 whereas in a mine east of Ottawa its rank index is 121. This difference is more than is usually found in any one coal bed within such a short distance. The higher rank index of the coal west of Ottawa appears to correlate with its lower moisture content. The low moisture may result from the higher topographic position of the coal west of Ottawa, where it is above the level of Illinois River and therefore has better drainage than the coal

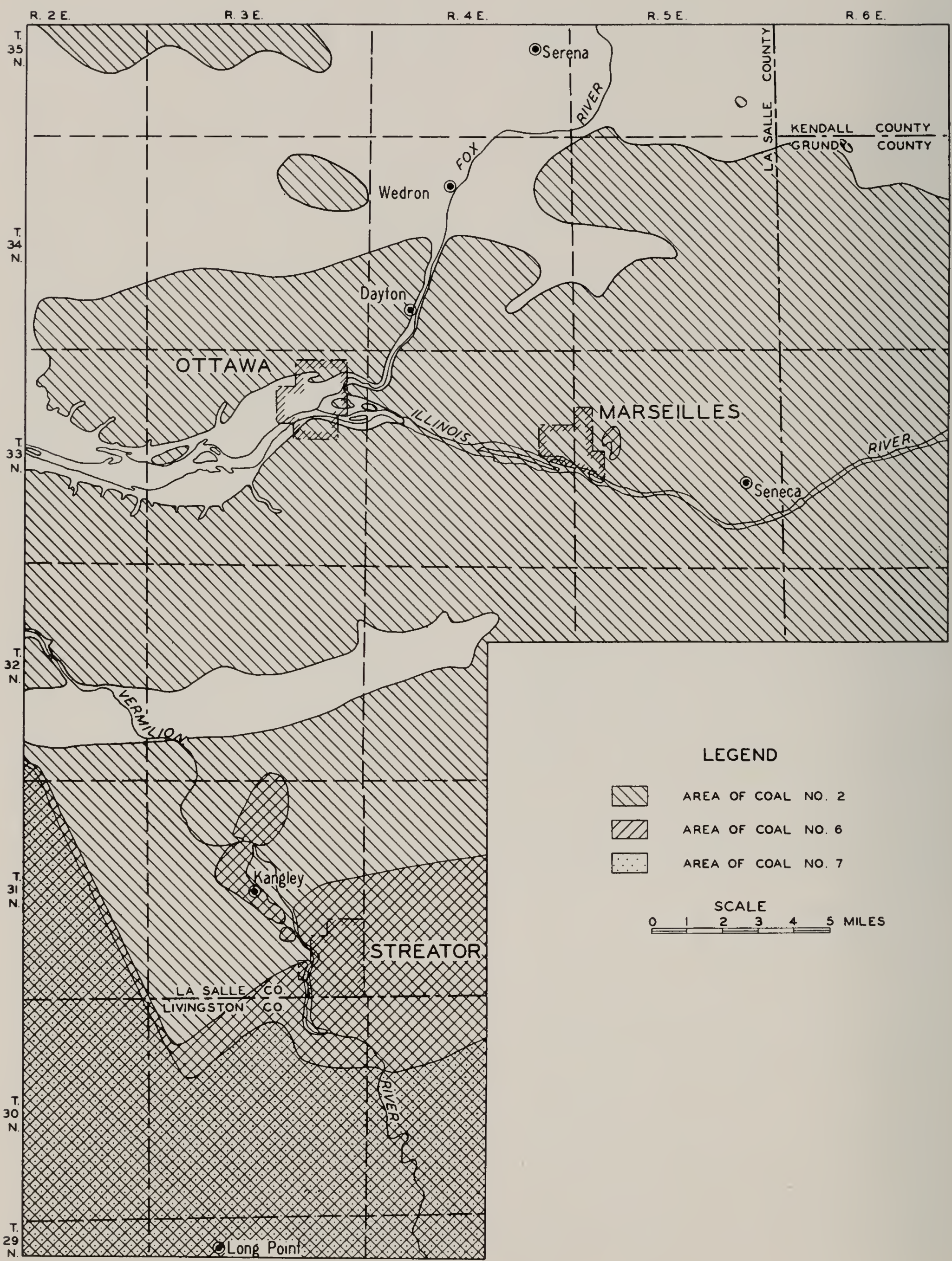



Fig. 117.—Area underlain by coals Nos. 2, 6, and 7 in the Marseilles, Ottawa, and Streator quadrangles.

farther east. However, the coal west of Ottawa is on the crest of the LaSalle anticline and the higher index might be related to its position on the structure.

The coal west of Ottawa has a higher rank than any of the other coals in the area which have been analyzed. The coal east of Ottawa has essentially the same rank index as coal No. 2 where it is mined in the LaSalle district west of the LaSalle anticline (app. H, table 2) and also coal No. 6 at Streator. However, the analyses show that coal No. 2 near Ottawa has twice as much sulphur as the same bed in the LaSalle district and as coal No. 6 at Streator.

FIG. 118.—Stripping the LaSalle (No. 2) coal at mine of Osage Coal Company, west of Ottawa, south part sec. 11, T. 33 N., R. 2 E. (Utica Twp.), Ottawa quadrangle.

### INDUSTRY

The principal production from coal No. 2 at present is from strip mines near the outcrop of the coal in the Ottawa quadrangle, but the coal is also worked near Marseilles by a shaft mine. Most of these operations have tipples equipped for sizing the coal and one company washes it. A number of small drift mines are intermittently operated along the outcrop of the coal (pls. 4-6).

On the upland north of Illinois Valley and five miles west of Ottawa, the Osage Coal Company has stripped a large area in secs. 11, 13 and 14, T. 33 N., R. 2 E. (Utica Twp.), Ottawa quadrangle (fig. 118). The coal is about 1 foot 10 inches thick and has an overburden 10 to 25 feet thick. The coal is screened at a tipple a mile north of the mine, on U. S. Highway No. 6, at the northwest corner of sec. 12, and the screenings are washed at a tipple on the Chicago, Rock Island and Pacific Railroad in the SE. ¼ NW. ¼ SW. ¼ sec. 13.

The Buffalo Rock Coal Company has stripped most of the coal from the top of Buffalo Rock west of Buffalo Rock State Park in secs. 18 and 19, T. 33 N., R. 3 E. (Ottawa Twp.), Ottawa quadrangle, where the coal is usually 1 foot 10 inches thick and has an overburden of 10-20 feet. A tipple is located on the north side of Buffalo Rock, in the NW. ¼ SW. ¼ SE. ¼ sec. 18.

The Ottawa Mining Company strips coal on the east side of Ottawa, in the SE. ¼ sec. 1, T. 33 N., R. 4 E. (Ottawa Twp.), Ottawa quadrangle, where the coal is 2 feet to 2 feet 6 inches thick and has an overburden of 18-20 feet. The coal is loaded in the mine directly to a portable screening device mounted on a truck.

The Wilmington Coal Mines, Inc., strips coal at the Echo Mine two miles east of Ottawa, on the north side of Illinois Valley, in secs. 7 and 8, T. 33 N., R. 4 E. (Rutland Twp.), Ottawa quadrangle, where the coal is usually 2 feet 2 inches thick and has 15-25 feet overburden. The tipple is in the center SW. ¼ sec. 9, on U. S. Highway No. 6.

South of Marseilles the Illinois Valley Coal Company operates a shaft mine in the NE. ¼ NW. ¼ NE. ¼ sec. 25, T. 33 N., R. 4 E. (Fall River Twp.), Marseilles quadrangle. The coal is reached at a depth of 110 feet and averages about 2 feet 6 inches thick.

As previously mentioned, the coal is also recovered in mining the associated shale and clay at several places near Ottawa and Marseilles. The Chicago Retort and Firebrick Company recovers the coal in stripping the refractory clay below the coal east of Ottawa, in the SW. ¼ sec. 5, T. 33 N., R. 4 E. (Rutland Twp.), Ottawa quadrangle. The coal is usually 2 feet thick and has 15 to 25 feet of overburden. It is also recovered in stripping the clay at the pit of the Fox River Clay Works at Dayton, in the NE. ¼ SE.

¼ sec. 29, T. 34 N., R. 4 E. (Rutland Twp.), Ottawa quadrangle.

A small amount of coal is recovered in stripping the overburden—which includes the coal—at several of the silica-sand pits in the north bluff of Illinois Valley west of Ottawa. The coal is usually a little less than 2 feet thick in this area.

Small drift mines are operated from time to time along the outcrop of the coal in the south bluff of Illinois Valley west of Ottawa and along Vermilion River in the northwest corner of the Streator quadrangle (pls. 5, 6).

Because of the thinness of the coal and the presence of a shale roof, the underground mines have mostly used the longwall method of mining. By this method the coal is undercut during the day and the slightly subsiding roof breaks down the coal during the night. As mining proceeds the coal face recedes from the shaft pillar in a widening circle. Because of the large amount of waste debris, mostly taken from the roof to give clearance along the entries, the locations of the mines which work or worked the LaSalle (No. 2) coal are distinguished by the presence of large waste-piles (fig. 4).

MINED-OUT AREAS

Only a comparatively small part of the area underlain by coal No. 2 has been mined. The largest mined-out areas are those of the strip mines currently operated (pl. 5). In addition the coal has been stripped from smaller areas southeast of Ottawa in the S. ½ sec. 7 and the N. ½ sec. 18, T. 33 N., R. 4 E. (Fall River Twp.); east of Ottawa in the center of sec. 6, T. 33 N., R. 4 E. (Ottawa Twp.); in the W. ½ of sec. 7, T. 33 N., R. 4 E. (Rutland Twp.), and in the NE. ¼ sec. 12, T. 33 N., R. 3 E. (Ottawa Twp.), in the northeast part of Ottawa in the SW. ¼ NW. ¼ sec. 1, T. 33 N., R. 3 E. (Ottawa Twp.); northeast of Utica in center sec. 10, T. 33 N., R. 2 E. (Utica Twp.); and south of Starved Rock State Park in the center sec. 21, T. 33 N., R. 2 E. (Deer Park Twp.), Ottawa quadrangle.

The coal has also been worked at several shaft mines which are now abandoned, but the workings of the largest extended only about one-fourth mile from the shaft. In the Streator quadrangle two mines were operated at Streator, one principally for mining the underclay, two at Kangley, one at Heenanville, and two about three miles northeast of Leonore. In the Marseilles quadrangle two shaft mines have been operated at Seneca, one 1½ miles east of Marseilles, and another the same distance west of Marseilles.

RESOURCES

The LaSalle (No. 2) coal underlies a large part of the quadrangle and the reserves are large. Assuming the coal has an average thickness of about 2 feet 6 inches in the Streator quadrangle and about 2 feet in the Ottawa and Marseilles quadrangles, the area contains approximately one billion tons of this coal. The coal may not be minable in parts of the area where no data are available but the uniformity of the coal in outcrops and the fact that it is reported in all but a few well records, and these are of questionable accuracy, supports the belief that the coal is uniformly present.

*Possible Areas for Strip Mining*[10]

Several areas where the coal may possibly be stripped occur along the outcrop in the Ottawa quadrangle, mostly near the present strip mines. Drill-testing of the areas is necessary to determine the character and thickness of both the overburden and the coal.

*East of Ottawa.*—The coal occurs at a shallow depth along the north and south sides of Illinois Valley one and two miles east of Ottawa, but much of the coal with a very thin overburden has been removed. A progressively heavier overburden will be encountered away from the river and to the east. The coal generally dips easterly 10 to 15 feet per mile, although this is locally modified by minor structures. On the north side of the valley, in the SE. ¼ SE. ¼ SW. ¼ sec. 9, T. 33 N., R. 4 E. (Rutland Twp.), Ottawa quad-

[10]Data on the depth and thickness of the coal near Illinois Valley in the Marseilles and Ottawa quadrangles are given on a map by G. H. Cady, "Illinois Valley from LaSalle to Morris": Illinois Geol. Survey, blue-line print, Sept. 1936, and Information Circular 19, Feb. 1937.

rangle, half a mile east of the Echo mine, the coal is about 35 feet deep but is shallower near the river.

*Northeast of Ottawa.*—The coal has been stripped in a small area northeast of Ottawa, along the abandoned feeder of the Illinois and Michigan Canal in the S. ½ sec. 6, T. 33 N., R. 4 E. (Ottawa Twp.), Ottawa quadrangle. The coal is about 15 feet deep in this area and about 2 feet thick. It is possible that the adjacent area can be stripped. Locally the roof shale has been eroded and the coal is of poor quality where overlain by gravel.

In an area of about 160 acres in the N. ½ sec. 6, the coal has a shale roof but is probably 25 to 35 feet deep and about 2 feet thick. The area is along the Chicago, Burlington and Quincy Railroad and half a mile east of a paved road at the northeast corner of Ottawa.

*West of Ottawa.*—The coal may also be strippable in part of the upland area near the north bluff of Illinois Valley between Twin Bluffs and Higbee Ravine. The coal is being stripped by the Osage Coal Company at Higbee Ravine, and it may be strippable in parts of secs. 12-14, T. 33 N., R. 2 E. (Utica Twp.), and secs. 17, 18, T. 33 N., R. 3 E. (Ottawa Twp.). The overburden is about 20 feet thick at Higbee Ravine and gradually increases in thickness eastward as the coal dips in that direction about 15 feet per mile. The overburden is probably less than 20 feet thick only near the bluff and the coal is probably a little less than 2 feet thick.

*Northeast of Utica.*—Some strippable coal may also occur near the outcrop line of the coal in the upland areas northeast of Utica (pl. 12), especially in secs. 25-28, 33-36, T. 34 N., R. 2 E. (Waltham Twp.), and in secs. 1-4, 10-12, T. 33 N., R. 2 E. (Utica Twp.), Ottawa quadrangle. Little information about the thickness of the coal is available, especially in the northern part of this area, but it is probably about 2 feet thick or a little less. The overburden probably varies from 15 to 50 feet in the sections listed and the thinnest overburden probably occurs where the ground surface is comparatively low in the southern part of the area and along the upper part of Clark Run and near Sargent school in the northeast part of the area. The area is crossed by U. S. Highway No. 6.

*South of Utica.*—It is possible that the coal could be stripped south of Starved Rock State Park, in the SE. ¼ sec. 21, T. 33 N., R. 2 E. (Deer Park Twp.). The coal is about 2 feet 4 inches thick and has an overburden only 5 to 10 feet thick near the outcrop but increasing southward to 35 to 40 feet near State Highway No. 71.

*Other areas.*—Elsewhere in the area the coal is generally covered by an overburden too thick to be stripped under present conditions. Along the margin of the coal in the north part of the Marseilles quadrangle (pl. 12) the coal generally occurs at a depth of more than 75 feet and it is probably less than 2 feet thick except near the east boundary of the area where it is 2 feet 6 inches thick.

The coal may also be stripped from small areas in the flats of several of the valleys near the outcrop of the coal, although in some cases the amount of available coal may not be large enough to warrant the expense of moving in equipment. The following areas are the most promising:

Along the stream south of Kenny school, in the NW. ¼ sec. 9 and the NE. ¼ sec. 8, T. 33 N., R. 3 E. (Ottawa Twp.), Ottawa quadrangle.

Along Covel Creek above the center of sec. 27 and possibly in the terrace in the NE. ¼ NW. ¼ sec. 27, T. 33 N., R. 3 E. (South Ottawa Twp.), Ottawa quadrangle.

Along the stream through the central part of sec. 29, upstream from the NW. ¼ SE. ¼ NE. ¼ sec. 29, T. 33 N., R. 3 E. (South Ottawa Twp.), Ottawa quadrangle.

Along Illinois Canyon south of the boundary of Starved Rock State Park, in the SE. ¼ NE. ¼ SE. ¼ sec. 25, T. 33 N., R. 2 E. (Deer Park Twp.), Ottawa quadrangle.

Along the stream in the NW. ¼ NW. ¼ sec. 15, T. 32 N., R. 2 E. (Deer Park Twp.), Streator quadrangle.

### *Possible Areas for Shaft Mining*

The most favorable areas for shaft mining probably are at Seneca and Streator, where the coal is usually about 3 feet thick, although on the west side of the LaSalle anticline in the southwest part of the Streator quadrangle the conditions for mining the coal may be even more favorable, as in the LaSalle area the coal is usually 3 feet 6 inches thick and is a somewhat better coal.

The depth of the coal throughout the quadrangle may be estimated from the map showing the elevation of the coal (pl. 12) and the topographic map showing the elevation of the surface (pls. 4-6). The coal has a depth of less than 250 feet throughout most of the area, although on the west side of the LaSalle anticline it descends sharply and probably is about 450 feet deep near the southwest corner of the Streator quadrangle.

## Lowell Coal

The Lowell coal (p. 105) occurs locally 20 to 30 feet above the LaSalle (No. 2) coal. It is commonly too thin to be worked, but several drill records at Kangley and Streator report between 2 and 3 feet of coal. In outcrops near Lowell the coal is only a few inches thick and is impure.

## Summum (No. 4) Coal

The Summum (No. 4) coal (p. 111) occurs from 60 to 70 feet above the LaSalle (No. 2) coal and has been worked on a small scale by a shaft mine a short distance southeast of Klein Bridge, on the Vermilion River flat in the SE. ¼ SE. ¼ SE. ¼ sec. 9, T. 31 N., R. 3 E. (Eagle Twp.), Streator quadrangle, where it is about 1 foot 10 inches thick and 40 feet deep. The coal is rarely as much as 4 inches thick where it crops out in the Ottawa and Marseilles quadrangles and along Vermilion River below Sandy Ford in the Streator quadrangle. However, the coal apparently thickens southward as indicated by records of borings and shafts, and minable areas of coal may be locally present, especially near Streator where 3 feet of coal is reported. At Heenanville the coal is reported to be of poor quality but information about its quality is lacking elsewhere.

## Coal below Herrin (No. 6) Coal

Near Streator a lenticular coal bed (Unit 43, p. 130) is locally present 10 to 20 feet below the Herrin (No. 6) coal. The coal is 1 foot to 2 feet 6 inches thick where stripped by the Bee Coal Company at the mouth of Eagle Creek, in the SE. ¼ SE. ¼ SE. ¼ sec. 22, T. 31 N., R. 3 E. (Eagle Twp.), and in the SW. ¼ SW. ¼ SW. ¼ sec. 23, T. 31 N., R. 3 E. (Bruce Twp.), Streator quadrangle. It has an overburden of 5 to 20 feet of shale and gravel and is underlain by 2 inches of hard black shale. Elsewhere in the area the coal is very thin or absent.

The analyses of three face samples of the coal (app. H, table 2) show it has a rank index of 123, which is about the same as that of other coals in the area. Although it is a little higher than the other coals in moisture content, it is lower in ash and sulphur.

## Herrin (No. 6) Coal

The Herrin (No. 6) coal bed (p. 131) is 110 to 160 feet above LaSalle (No. 2) coal and occurs principally in the central and south part of the Streator quadrangle and in a small area near Marseilles (fig. 117). A large area at Streator where the coal bed was comparatively thick has been mined out. The coal has been called the "Streator" coal and correlated with No. 7 coal elsewhere in the State, but it has been shown by the present study to be equivalent to the Herrin (No. 6) coal bed and the "Second Vein" of the LaSalle district. The coal has a shale roof at Streator but at Heenanville and Kangley commonly has a hard black shale ("slate") roof although at some places it is separated from the "slate" by lenses of shale. The coal is underlain by "slate" in some areas and by clay in others.

### CHARACTER

The coal is generally thick in the Streator area but varies from about 3 feet to as much as 9 feet (p. 131). It commonly contains several bands of clay and bony coal which necessitates working it in two or three benches (fig. 76 and app. A, geol. secs. 17, 19, 24, 25). The clay partings were absent in part of the area now mined out at Streator, but they increase in thickness and abundance to the south and east. Similar partings are also present in the Kangley-Heenanville area northwest of Streator but are less abundant than in most of the Streator area. At Heenanville where the coal is unusually thick, there is a 2- to 6-inch band of black shale "slate" at about the middle, and the upper coal is reported to be lighter in weight and to burn faster than the lower coal. The coal commonly contains pyrite, mostly in small nodules or lenses along the bedding-planes. Clay occurs in "veins" or "horsebacks" which cut irregularly through the coal, usually at small faults where the coal is offset a foot or two. Depressions or "rolls" 1 to 2 feet deep and filled with shale are locally common in the top of the coal.

At Marseilles the coal is 3 to 5 feet thick and contains several bands of clay and a considerable quantity of bony coal.

The analyses of samples from two mines near Streator (app. H, table 2) show that coal No. 6 has a rank index of 125. It is therefore slightly higher in rank than the other coals in the quadrangles, except for an area of coal No. 2 west of Ottawa (p. 253).

### INDUSTRY

Several mines near Streator, Kangley, and Heenanville produce coal for local use from the Herrin (No. 6) coal bed. The coal is mined by shaft, slope, drift, and strip mines. The underground mines use the room-and-pillar method. In the Kangley-Heenanville area, natural joints ("facings" or "cleat") are poorly developed and the mines are laid out with the entries north-south and east-west. At Streator the coal has distinct and uniform facings about 30° west of north and the mines are laid out with entries parallel to and normal to that direction.

At Heenanville 8 to 9 feet of coal is worked by the French Coal Company in the SW. ¼ SE. ¼ SW. ¼ sec. 3, T. 31 N., R. 3 E. (Bruce Twp.), Streator quadrangle, by a shaft which reaches the coal at a depth of 100 feet. At Marilla Park, one mile north of Streator, the Blue Eagle Mine works 3 to 4¼ feet of coal at a depth of 65 feet. Southwest of Streator, in the Canelo Mine, formerly the Kimes Mine, in the NE. ¼ SE. ¼ NE. ¼ sec. 4, T. 30 N., R. 3 E. (Reading Twp.), the coal is 4-5 feet thick and 90 feet deep. The coal is also worked at a shaft two miles west of Kangley in the SE. ¼ SW. ¼ SE. ¼ sec. 18, T. 31 N., R. 3 E. (Eagle Twp.), at several drift mines and a strip mine along Vermilion River at Klein Bridge, and by several drift, slope, and shallow shaft mines along the river between the mouth of Eagle Creek west of Streator and the city reservoir southeast of Streator. Mines are opened from time to time in small blocks of coal between or adjacent to the large mined-out areas of the old shipping mines at Streator, and a small amount of coal has been produced from the pillars in the old mines. In several pits at Streator the shale which overlies the coal is stripped for use in the manufacture of clay products and a little coal is recovered, but in most of these pits much of the coal had been mined before the pits were opened.

### MINED-OUT AREAS

A large area at Streator, Kangley, and Heenanville where the coal is more than 4 feet thick was mined out many years ago. The principal mined-out areas are shown on plate 6, which does not include the areas worked by the small drift mines along Vermilion River. The exact extent of the mined-out area in secs. 10, 11, and 12, T. 30 N., R. 3 E. (Reading Twp.) is uncertain.

### RESOURCES

Although most of the thick coal at Streator appears to have been worked out, large parts of the adjacent areas have not been thoroughly tested and extension of the field may be possible. The coal or its horizon occurs below almost all the southern part of the quadrangle (fig. 117) but detailed information about the coal is lacking throughout most of that area. As the coal is erratic in occurrence throughout northern Illinois it may be absent or too thin to be minable.

At Streator the thick coal appears to occur in channel-like depressions most of which trend from northeast to southwest. Consequently prospecting might reveal workable deposits of the coal southwest of Streator in the area between the Alton and the Atchison, Topeka and Santa Fe railroads. The exact position of the margin of the coal west and southwest of Streator in Eagle, Reading, and Osage townships is uncertain, as few wells in that area penetrate bedrock. The bedrock is not deep in part of that area and the strata rise to the west so that the coal, if present, may be sufficiently shallow to be stripped in some places.

The coal apparently does not extend far north of Streator, as it rises at the margin of a channel and is cut out by glacial deposits. Northeast of Streator the exact boundary of the coal is uncertain but north of Otter Creek the coal is probably eroded along a preglacial valley. The coal is reported to have had a poor roof in the old mines in the northeast part of Streator. East of Streator the coal has been mined as far as the NW. ¼ sec. 32, T. 31 N., R. 4 E. (Otter Creek Twp.), but in the old mines the coal is reported to have become "dirty" in that direction, and south of Streator the coal also contains many shale partings.

Although a large area has been mined out in the southern part of the Heenanville field, workable coal remains in sec. 3, in the SE. ¼ SE ¼ sec. 4, and in the NE. ¼ sec. 9, north and west of the mined-out area. The coal probably does not extend much farther north because of a preglacial valley, and westward it rises at the margin of a channel and is cut out by glacial drift.

At Kangley most of the thick coal has probably been mined out, but patches of workable coal may be present southwest of the mined area, especially in secs. 17-20, 29, and 30, T. 31 N., R. 3 E. (Eagle Twp.), Streator quadrangle.

Coal No. 6 in the Streator field is considered as mined out but inasmuch as the room-and-pillar method was used in mining, actually about half the coal originally present remains in the ground. The coal in the old pillars may someday be an important source of coal for this region. Small blocks of coal between the mines or adjacent to them are probably large enough to supply the local demand for many years.

Coal No. 6 has been mined northeast of Marseilles along Gum Creek, where it is at least locally as much as 5 feet thick. Most of the thick coal near Gum Creek has probably been worked out by a small strip mine and several drift mines. However, the coal may extend northeast from Gum Creek, as water wells in secs. 8-12, T. 33 N., R. 5 E. (Manlius Twp.), are reported to have penetrated from a trace to 3 feet of coal at 100 to 155 feet above LaSalle (No. 2) coal and at a depth of 90 to 160 feet.

Coal No. 6 may also be locally present near the southeast corner of the Marseilles quadrangle. A water well in the NE. ¼ SE. ¼ sec. 27, T. 33 N., R. 6 E. (Norman Twp.), penetrated one foot of coal at a depth of 80 feet, 125 feet above coal No. 2.

## Sparland (No. 7) Coal

The Sparland (No. 7) coal, equivalent to the "First Vein" coal in the LaSalle area, occurs in the Streator quadrangle south of Streator (p. 137 and fig. 117). It is not as thick as coals Nos. 2 and 6 but it has been worked on a small scale at several places. Coal No. 7 occurs between 200 and 225 feet above the LaSalle (No. 2) coal and about 50 feet above the Herrin (No. 6) coal, although the latter interval varies considerably on account of the variations in elevation of coal No. 6. Coal No. 7 usually has a shale roof, although in places the shale is cut out by channels which are filled with sandstone. In some areas the sandstone cuts into the coal, greatly reducing the thickness of the coal and locally cutting it out completely. The coal is underlain by a thick underclay.

### CHARACTER

The coal is between 2 and 3 feet thick except where its upper part was eroded along the bases of the sandstone-filled channels. It contains few partings and in appearance resembles the LaSalle (No. 2) coal.

No analysis of coal No. 7 in these quadrangles is available but the same bed in

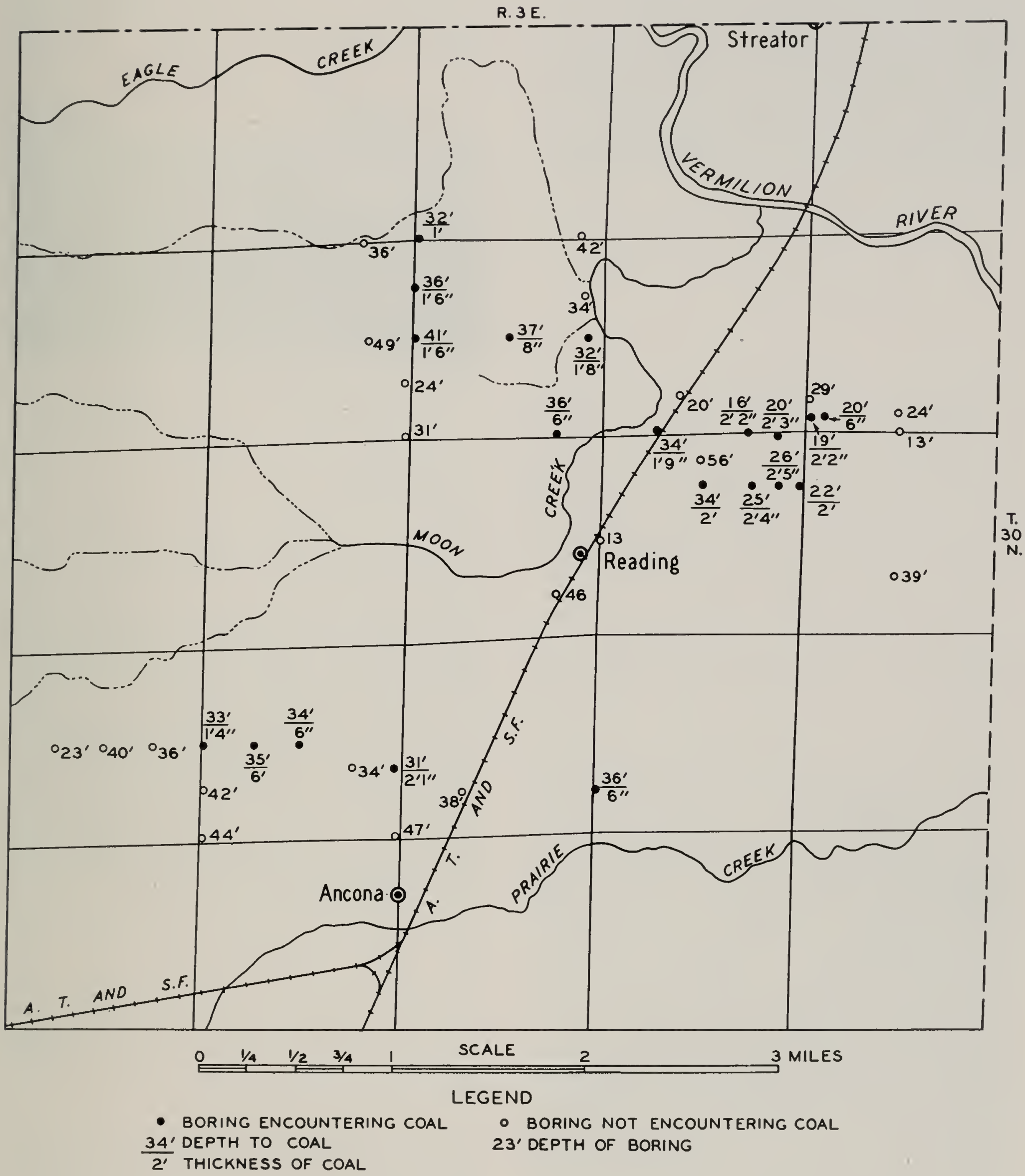



FIG. 119.—Thickness of Sparland (No. 7) coal and its overburden south and southwest of Streator.

the Sparland area has a rank index of 119 (app. H, table 2) and therefore is slightly lower in rank than the other coals in the Marseilles-Ottawa-Streator area.

#### INDUSTRY

None of the mines in coal No. 7 are active at present but a small amount of coal has recently been stripped along the east side of Vermilion River in the NW. ¼ NE. ¼ sec. 18, T. 30 N., R. 4 E. (Newtown Twp.), and along Moon Creek in the center SW. ¼ sec. 11, T. 30 N., R. 3 E. (Reading Twp.), Streator quadrangle. The coal has been mined by a shaft at the NE. corner SE. ¼ sec. 13, T. 30 N., R. 3 E. (Reading Twp.).

#### RESOURCES

Coal No. 7, or its horizon, occurs throughout the south part of the Streator quadrangle, but in a considerable part of that area the coal may have been eroded or greatly reduced in thickness along the sandstone channels and careful prospect drilling will be necessary to outline workable deposits of coal.

The coal is probably not generally thick enough nor of good enough quality to be worked by shaft mines, but it may be strippable locally. The results of drill-testing south of Streator (fig. 119) suggest that the most favorable area is near the Defenbaugh school and includes most of the NE. ¼ sec. 14, S. ½ SE. ¼ sec. 11, SW. ¼ SW. ¼ SW. ¼ sec. 12, T. 30 N., R. 3 E. (Reading Twp.), Streator quadrangle. The coal is 2 feet to 2 feet 6 inches thick and has an overburden 15 to 25 feet thick. As no tests were made in sec. 13, the area of shallow coal may be extended eastward to include the tract south of the outcrop line. Borings northwest of Reading in secs. 10 and 11 revealed a maximum of 1 foot 8 inches of coal and 30 to 40 feet of overburden. Several of the borings apparently were not deep enough to reach the coal. Most of the borings north of Ancona in secs. 20, 21, and 22 penetrated a heavy sandstone that may have cut out the coal, but many of them may not have extended deep enough to reach the coal. One boring in this area penetrated 2 feet 1 inch of coal at a depth of 31 feet. It is reported, also, that water wells in sec. 19, T. 30 N., R. 3 E. (Reading Twp.), penetrated 2 feet of coal at a depth of 20 feet.

The coal is probably much deeper west of the LaSalle anticline in the southwest part of the Streator quadrangle. At Wenona, two miles west of the quadrangle, the coal is 3 feet 4 inches thick and is 334 feet deep.

Fig. 120.—Plant for washing and screening sand and gravel, operated by the Moline Consumers Company, west of Ottawa, NW. cor. sec. 19, T. 33 N., R. 3 E. (Ottawa Twp.), Ottawa quadrangle.

## SAND AND GRAVEL

The excellent system of gravel roads throughout the Marseilles-Ottawa-Streator area reflects the abundance of local deposits of sand and gravel. Deposits of sand and gravel suitable for surfacing roads occur in most of the townships and are especially common along the major valleys. Most of the deposits are also suitable for use as concrete aggregate when washed. The deposits of silica sand and natural-bonded molding sand are described in separate sections.

#### INDUSTRY

The importance of the sand and gravel industry in the area is indicated by the presence of between 125 and 150 pits. Many of the pits are small and only a few are operated at any one time. Although many have not been operated for years, nearly all of them can be reopened if the demand arises.

Two plants in the area wash and screen gravel and sand to meet specifications for concrete aggregate, road metal, plastering sand, and other uses. They are operated by the Moline Consumers Company four miles west of Ottawa near the NE. cor.

Fig. 121.—Gravel pit of the Moline Consumers Company, west of Ottawa, SW. ¼ SW. ¼ sec. 18, T. 33 N., R. 3 E. (Ottawa Twp.), Ottawa quadrangle.

Fig. 122.—Gravel pit with portable loading equipment, north of Marseilles, near center NW. ¼ sec. 18, T. 34 N., R. 5 E. (Miller Twp.), Marseilles quadrangle.

sec. 24, T. 33 N., R. 2 E. (Utica Twp.), Ottawa quadrangle (figs. 120, 121), and the Spicer Gravel Company two miles east of Marseilles in the NE. ¼ SE. ¼ NW. ¼ sec. 21, T. 33 N., R. 5 W. (Manlius Twp.), Marseilles quadrangle (fig. 91).

Most of the other pits produce material chiefly for roads and have no permanent equipment. The material is loaded by hand, or portable excavating, screening, and crushing equipment is temporarily used (fig. 122). Road gravel is produced by the Ottawa Road Gravel Company, a subsidiary of the Moline Consumers Company, which is equipped with a power shovel, belt conveyors, and screening, crushing, and loading equipment (fig. 123). The Cephas Williams Gravel Company produces road gravel one mile northeast of Streator, in the NW. ¼ NW. ¼ sec. 20, T. 31 N., R. 4 E. (Otter Creek Twp.), Streator quadrangle.

## USES

Nearly all the gravel deposits of the area can supply material suitable for surfacing secondary roads. However, many of them contain some oversize material that should be removed or crushed, and some contain too small an amount of clay and silt to bind the material effectively unless clayey material is added to the gravel.

Many of the deposits are sufficiently free from soft rocks and other undesirable materials to be suitable for concrete aggregate, bituminous road construction, and railroad ballast if the material is properly washed and screened to meet specifications. Some of the deposits contain very little clay and silt and have been used without washing for concrete aggregate for small structures.

Sand suitable for concrete, plasters, mortars, brick pavements, and other uses can be produced from the sand deposits

Fig. 123.—Gravel pit of the Ottawa Road Gravel Company, south of Ottawa, SE. ¼ SW. ¼ SE. ¼ sec. 15, T. 33 N., R. 3 E. (South Ottawa Twp.), Ottawa quadrangle, showing the shovel, belt conveyors, and, in the background, the crushing and loading plant.

and from the sand screened from the gravel deposits. Although these sands are composed largely of quartz (silica) they are all calcareous except in the thin weathered surficial zones and are not generally suitable for foundry uses or for the uses requiring silica sands.

### TYPES OF DEPOSITS

Most of the gravel and sand deposits are of glacial origin (p. 142) although some have resulted from the present rivers and streams reworking the glacial materials. The deposits are of four types as follows:

*Morainal deposits.*—The morainal deposits are those which were formed below, in, or at the edge of the glaciers and occur mostly in the terminal moraines. They include the kames, the eskers, and the deposits along subglacial channels (p. 142). They are composed of material that is highly variable in composition, usually poorly sorted, and angular. They have irregular bedding, commonly contain balls of clayey or silty till, and in general are more clayey than the other deposits.

*Outwash deposits.*—The outwash deposits are those which were laid down on outwash plains in front of the glacier or by streams along the valleys which carried the drainage from the ice (p. 143). They are composed mostly of well-sorted and well-rounded materials and contain comparatively little clay and silt. Clay balls are rare but occur locally in outwash deposits formed near the margin of the ice, where they grade into morainal deposits. The outwash deposits are mostly horizontally bedded but in places are cross-bedded. They are more uniform than the other types of deposits.

*Delta deposits.*—Deltas were formed where the glacial streams entered lakes, and most of them were formed near the margin of the ice (p. 143). The deltas are characterized by parallel steeply-dipping foreset beds which are continuous for many feet. Some of the deltas have a silt band above the foreset beds and cross-bedded gravel and sand above the silt. The materials are poorly sorted, cobbly or bouldery, angular, and usually include till balls and a considerable quantity of clay and silt.

*Recent deposits.*—Many of the present rivers and streams have reworked some of the glacial materials into deposits of gravel and sand along their channels and in their floodplains (p. 178). Fragments of the bedrock are common in the deposits along those streams which erode bedrock. The Recent deposits are highly variable and frequently contain much clay and silt.

### COMPOSITION

Because of their glacial origin, the gravel and sand deposits are composed of a large variety of materials representing the many kinds of rock which occurred in areas crossed by the glaciers.

The pebbles in the gravel deposits are predominately limestone and dolomite, although fragments of igneous rocks such as granite, basalt, and peridotite, and of metamorphic rocks such as quartzite, gneiss, and schist, are common. The igneous and metamorphic materials are relatively more abundant among the cobbles and boulders. Chert is generally present and is usually more common among the smaller pebbles. It rarely forms as much as 5 per cent of the deposits. Fragments of the local bedrock, such as shale, sandstone, "slate," coal, and limestone, are abundant in some deposits and locally form as much as 50 per cent of the material. Rounded balls of pebbly or silty till are locally abundant.

The sand grains in the sand deposits and in the sand fraction of the gravel deposits are composed largely of quartz, although the very coarse-grained sand from the gravel deposits usually contains a large percentage of the same materials that comprise the pebbles. Quartz is usually predominant in all the sand less than 1 mm. in diameter.

The clay and silt in the sand and gravel deposits is a highly calcareous mixture of quartz and clay minerals. Clay and silt together are usually less than 10 per cent and are less than 2 per cent in some deposits.

### RESOURCES

The known sand and gravel deposits of the Marseilles-Ottawa-Streator area are very large and widely distributed, and undoubtedly many additional deposits will be found, especially in the morainal areas. Most of the deposits are irregular in thickness and areal extent, and in many cases the limits of the deposits are not evident from the topography but must be determined by test-borings or test-pits. A few of the larger deposits have been roughly outlined by auger borings, but as these penetrated only the upper few inches of the gravel or sand it is not certain that the deposits are of workable thickness.

Many sand and gravel deposits vary in coarseness both laterally and vertically. Consequently the descriptions based on outcrops and exposures in pits may not apply to the deposit as a whole. The samples tested represent only one place in the pits, and considerable variations from the results are to be expected.

The location of the areas described below are shown in fig. 124, and the approximate extent of the larger deposits is shown on plates 1, 2, and 3. Many small deposits are not described, especially those which occur near larger deposits or under a heavy overburden.

*Area 1, Lake Wauponsee plain.*—Sand and gravel occur locally in the area covered by Lake Wauponsee in the Marseilles quadrangle (pl. 1). Fine sandy gravel[11] and sand occur in the low ridge, which is a delta deposit (p. 164), extending northeast from the center of sec. 15, T. 34 N., R. 6 E. (Nettle Creek Twp.), to the margin of the quadrangle. Where exposed in a small pit worked for road gravel in the center of sec. 15, the deposit is a fine sandy gravel (app. D, table 6, W-10), probably not more than 15 feet thick, and has an overburden of 3 to 4 feet of brown silt.

A thin deposit of gravel occurs along O'Brien Run in the central part of sec. 2, T. 33 N., R. 6 E. (Erienna Twp.). Only 3 feet of fine gravel with an overburden of about equal thickness is exposed.

*Area 2, Marseilles moraine.*—Gravel for surfacing the local roads has been produced from several pits on the Marseilles moraine in the Marseilles and Ottawa quadrangles. The largest deposits occur along Brumbach Creek, six miles north of Marseilles, where several pits have been opened(p. 163). The deposits underlie a large area in the north part of sec. 18 and the south part of sec. 8 and extend into adjacent sections in T. 34 N., R. 5 E. (Miller Twp.), Marseilles quadrangle. The deposits are locally as much as 40 feet thick but are usually thinner. The material is mostly a fine sandy gravel (app. D, table 6, W-8) where exposed in a pit in the NW. ¼ sec. 18 (fig. 95). They are more uniform in character than common for morainal-type gravels. Similar but thinner deposits occur along many of the other valleys which occupy reentrants in the front of the Marseilles moraine (pls. 1, 2.)

Gravel occurs in several small kames and eskers near the crest of the moraine south of Marseilles (p. 163). The material exposed in a pit in the NE. ¼ NW. ¼ NW. ¼ sec. 8, T. 32 N., R. 5 E. (Brookfield Twp.), is a fine sandy silty gravel (app. D, table 6, W-13). The deposit is locally at least 35 feet thick, of which 20 feet is below water. It has an overburden of till from 1 to 10 feet thick.

*Area 3, Illinois Valley.*—Sand and gravel deposits occur at many places on the floor and in the bluffs of Illinois Valley in the Marseilles and Ottawa quadrangles. In addition to the larger deposits later described separately, many smaller deposits are present. Pits have been opened in a few (pls. 1, 2) and many of them may contain sufficient material to be of local use. Some of the deposits are low oval mounds, which are probably bars of outwash in a glacial river, and are probably only about as thick as the mounds are high and coextensive with the margins of the mounds. Sand and gravel are also locally exposed in the lower part of the valley-walls where they occur in small remnants of terraces and in beds overlain by thick deposits of till.

Gravel and sand, locally at least 20 feet thick, occurs in the channel of Illinois River, as shown by the test-borings for the Starved Rock dam and the Ottawa and Seneca bridges. Large quantities of coarse bouldery gravel and sand have been dredged from the channel in deepening the Illinois Waterway and deposited on the river banks. Shells and soft

[11]The usage of the terms describing the grain size of sand and gravel is given in appendix D, table 1.

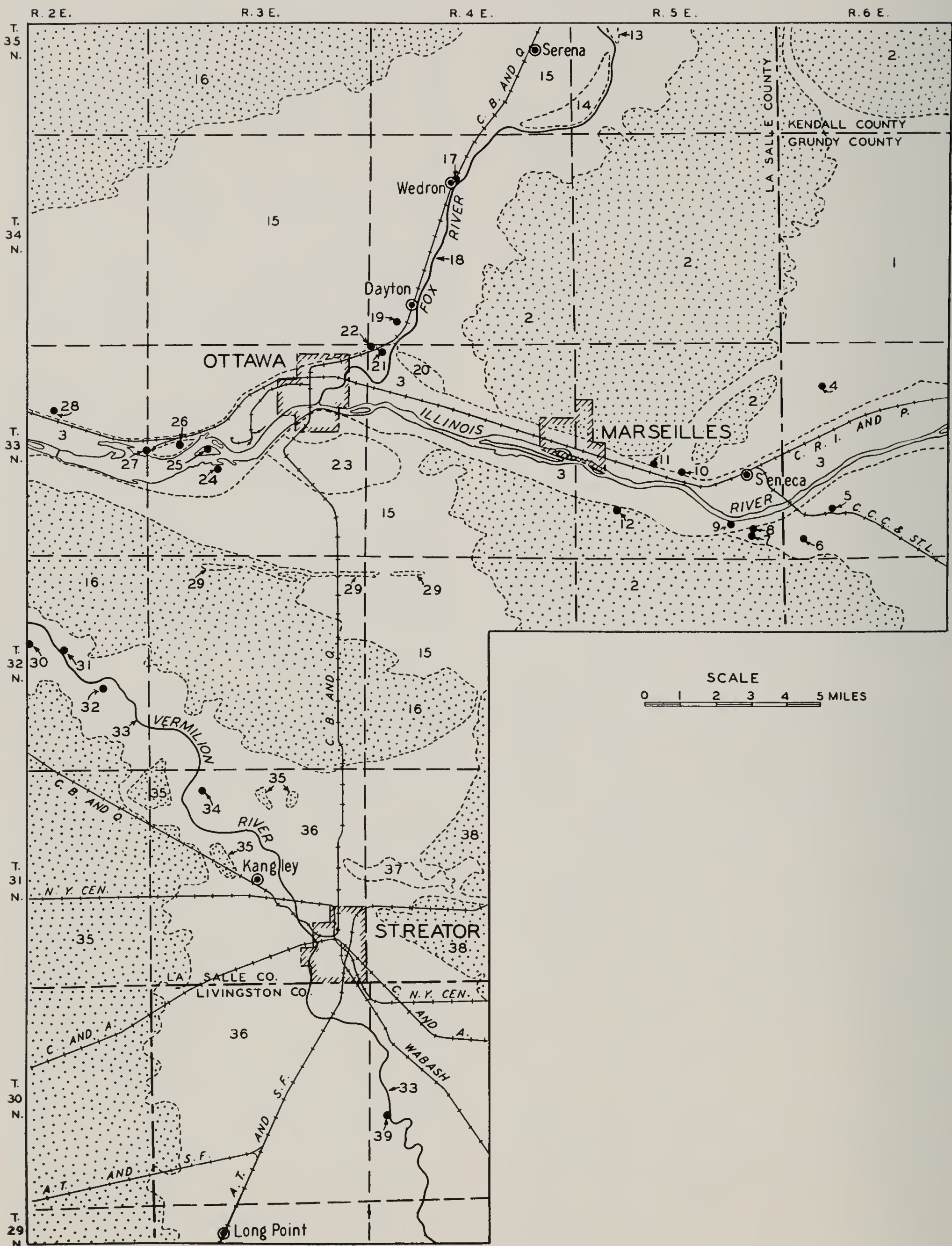



FIG. 124.—Locations of areas containing sand and gravel deposits.
(See text for description of numbered areas)

rocks are common and locally may be too abundant for use of the gravel in concrete aggregate.

*Area 4, northeast of Seneca.*—A delta deposit of gravel three miles northeast of Seneca along Stanton Creek, in the SW. ¼ NW. ¼ NW. ¼ sec. 8, T. 33 N., R. 6 E. (Erienna Twp.), Marseilles quadrangle, has been worked for road gravel. The material is a fine sandy gravel (app. D, table 6, ML-195, W-20) but differs from most of the deltas in that it has no boulders and clay balls. A bed of silt 1 to 2 feet thick is present in part of the deposit. The deposit is 12 to 25 feet thick and has an overburden of 2 to 4 feet of brown silt. A large part of the deposit has been worked out.

*Area 5, southeast of Seneca.*—Thick outwash deposits of coarse sand, pebbly sand, and fine sandy gravel are exposed along Hog Run southeast of Seneca, in secs. 28-30, T. 33 N., R. 6 E. (Norman Twp.), Marseilles quadrangle. The deposits are all overlain by a thick deposit of till and could probably not be worked on a commercial scale. Sand for local use can be obtained from some of the outcrops or from reworked material along the stream.

*Area 6, southeast of Seneca.*—A delta deposit has been worked for road gravel along the east side of Armstrong Run two miles southeast of Seneca, in the SW. ¼ NE. ¼ sec. 31, T. 33 N., R. 6 E. (Norman Twp.), Marseilles quadrangle. The material is a fine sandy gravel (app. D, table 6, W-11) containing scattered boulders, clay balls, and a thin silt bed. The deposit is about 15 feet thick and has an overburden of 3 to 4 feet of silt. A similar but smaller deposit was formerly worked at a pit about half a mile northeast in the SW. ¼ NW. ¼ NW. ¼ sec. 32.

*Area 7, south of Seneca.*—A delta deposit of fine sandy gravel (app. D, table 6, W-12) has been worked for road gravel at two pits at the top of the bluff south of Seneca, in the NW. ¼ sec. 36, T. 33 N., R. 5 E. (Brookfield Twp.), Marseilles quadrangle. The deposit contains clay balls and thin beds of silt, is 10 to 20 feet thick, and has an overburden of 3 to 4 feet of silt. Its extent is uncertain but it may underlie a considerable area adjacent to the pits.

*Area 8, south of Seneca.*—A deposit of medium-grained sand (app. D, table 6, W-80) is exposed in the lower part of the Illinois Valley bluff south of Seneca, in secs. 25, 36, T. 33 N., R. 5 E. (Brookfield Twp.), and sec. 30, T. 33 N., R. 6 E. (Norman Twp.), Marseilles quadrangle. It has been worked for plastering sand at a pit in the northwest corner sec. 36 where the sand is calcareous, well-sorted, cross-bedded, and contains streaks of pebbles. It is 20 to 30 feet thick but is overlain by till which is more than 25 feet thick except in a narrow zone along the bluff.

*Area 9, southwest of Seneca.*—Outwash deposits of gravel and sand which have been worked principally for road gravel underlie a terrace along the south side of Illinois Valley one mile southwest of Seneca, in secs. 26, 34, 35, T. 33 N., R. 5 E. (Brookfield Twp.), Marseilles quadrangle. A medium gravel (app. D, table 6, W-19) exposed in a pit in the SW. ¼ SE. ¼ SW. ¼ sec. 26 is reported to be at least 40 feet thick, about 15 feet of which is above water-level (fig. 92). The overburden is 1 to 3 feet of silt. South of the road along the north side of sec. 35, the material penetrated in excavations for basements is reported to be largely sand, and sand is exposed in some shallow gullies along the inside of the terrace and along Spring Brook. A sample (p. 273) from an outcrop of 6 feet of sand in the NW. ¼ SE. ¼ NE. ¼ sec. 34, was a medium-grained sand similar to that described in Area 8.

*Area 10, west of Seneca.*—A small deposit of pebbly sand (app. D, table 6, ML-196, W-9) is exposed in a pit at the base of the bluff at Butterfield school 1½ miles west of Seneca, in the NE. ¼ NW. ¼ SW. ¼ sec. 22, T. 33 N., R. 5 E. (Manlius Twp.), Marseilles quadrangle. It contains many clay balls, is 15 to 20 feet thick, and has an overburden of 1 to 3 feet of silt and weathered gravel.

*Area 11, east of Marseilles.*—A thick deposit of sand and gravel is exposed along the north bluff of Illinois Valley two miles east of Marseilles, where it is dredged and washed by the Spicer Gravel Company. The material exposed consists of fine sandy gravel and medium- and fine-grained sand (app. D, table 6, ML-199, ML-200). The deposit is about 55 feet thick and has an overburden of about 20 feet of till (app. A, geol. sec. 47).

*Area 12, southeast of Marseilles.*—A small deposit of bouldery fine sandy gravel (app. D, table 6, ML-193), 15 to 25 feet thick, occurs at the mouth of South Kickapoo Creek southeast of Marseilles, in the NW. ¼ NE. ¼ SW. ¼ sec. 29, T. 33 N., R. 5 E. (Brookfield Twp.), Marseilles quadrangle. The material has been used on local roads.

*Area 13, northeast of Serena.*—Outwash deposits of gravel underlie a terrace on the east side of Fox Valley northeast of Serena, in the N. ½ sec. 20, T. 35 N., R. 5 E. (Mission Twp.), Marseilles quadrangle. Where exposed in a pit in the SW. ¼ SW. ¼ NE. ¼ sec. 20, the material is a fine gravel (app. D, table 6, W-6) 15 feet thick. The deposit has an overburden of 3 to 4 feet of brown silt except where locally overlain by dunes of brown fine-grained silty sand locally 10 feet high.

*Area 14, southeast of Serena.*—Outwash deposits of gravel underlie two large terraces on the north side of Fox Valley two miles southeast of Serena, in secs. 35, 36, T. 35 N., R. 4 E., and secs. 19, 20, 29-31, T. 35 N., R. 5 E. (Serena Twp.), Marseilles quadrangle. The terraces are adjacent but differ in elevation from 10 to 20 feet. The material in the lower terrace (p. 171) is a fine gravel (app. D, table 6, W-3) where exposed in a pit in the NE. ¼ SE. ¼ SE. ¼ sec. 35. It is at least 30 feet thick and has an overburden of 1 to 3 feet of brown silt but is probably thinner in the part of the terrace up the valley. The deposits in the higher terrace (p. 171) are generally thinner than in the lower terrace but are at least 10 feet thick locally and have an overburden of 1 to 3 feet of brown silt. Where exposed in a pit in the NE. ¼ NW. ¼ SE. ¼ sec. 30 the higher terrace deposits consist of fine gravel (app. D, table 6, W-1) but they are coarser in outcrops along the stream north of the pit.

*Area 15, Lake Ottawa plain.*—Thin deposits of gravel and sand occur at many places in the Lake Ottawa plain in the Marseilles, Ottawa, and Streator quadrangles. The deposits north of Illinois Valley in the Ottawa quadrangle are mostly too thin to be worked, although a small quantity of gravel for use on local roads has been excavated in the SW. ¼ NW. ¼ SW. ¼ sec. 15, T. 34 N., R. 2 E. (Waltham Twp.), and in the SW. ¼ NW. ¼ NE. ¼ sec. 5, T. 34 N., R. 4 E. (Dayton Twp.). A sample (app. D, table 6, ML-133) from the latter deposit was a fine sandy gravel. Similar thin deposits are exposed at places along the top of the bluffs of Fox Valley, Buck Creek, and Indian Creek, but the overburden is 3 to 4 feet thick.

Small deposits of gravel occur along nearly all the streams. Although these materials are highly variable in character, small quantities of material suitable for many uses on nearby farms and roads may be obtained by careful selection. Such materials are common along Indian, Buck, and Crooked Leg creeks. The terraces along Indian Creek contain a little gravel but are mostly underlain by brown medium-grained sand which in places is silty. The sand is 1 to 4 feet thick and has an overburden of 1 to 2 feet of sandy silt.

*Area 16, Farm Ridge moraine.*—Gravel and sand deposits are locally present on the Farm Ridge moraine in the Ottawa and Streator quadrangles and some have been worked for road gravel. In the northwest part of the Ottawa quadrangle the gravel is exposed in pits in the SE. ¼ NW. ¼ NE. ¼ sec. 29, T. 35 N., R. 3 E. (Freedom Twp.), and in the SW. ¼ SE. ¼ SE. ¼ sec. 16, T. 35 N., R. 2 E. (Ophir Twp.). The latter deposit is an outwash deposit along the front of the moraine and may underlie a large area. Where exposed it has an overburden of 6 feet of brown silt.

Gravel occurs in some of the steep-sided hills on the Farm Ridge moraine in the northwest part of the Streator quadrangle. A small amount of gravel has been taken from a pit in the NE. ¼ SW. ¼ SW. ¼ sec. 20, T. 32 N., R. 3 E. (Farm Ridge Twp.).

*Area 17, at Wedron.*—Gravel and sand underlie the terrace (p. 172) on which the village of Wedron is located, in the NE. ¼ and the NW. ¼ SE. ¼ sec. 9, T. 34 N., R. 4 E. (Dayton Twp.), Ottawa quadrangle. The material exposed in the pit in the NE. ¼ NW. ¼ SE. ¼ sec. 9, T. 34 N., R. 4 E. (Dayton Twp.), was a fine gravel (app. D, table 6, W-4). The deposit is 10 to 15 feet thick and has a variable overburden mostly 3 to 4 feet thick.

*Area 18, Fox Valley.*—The terraces in Fox Valley below Wedron in the Ottawa quadrangle are nearly all underlain by bedrock at a shallow depth, but small deposits of gravel and sand suitable for local use are present at a few places. Gravel occurs in a low terrace north of Sulphur Springs, and brown medium-grained sand 5 to 6 feet thick underlies a low terrace on the east side of the valley at Dayton.

*Area 19, southwest of Dayton.*—A delta deposit of gravel has been worked for road material on the west side of Fox Valley half a mile southwest of Dayton, in the SW. ¼ NW. ¼ sec. 32, SE. ¼ NE. ¼ sec. 31, T. 34 N., R. 4 E. (Dayton Twp.), Ottawa quadrangle. The material is fine gravel and fine sandy gravel (app. D, table 6, ML-181, W-5) but contains many boulders and clay balls. The deposit is 20 to 30 feet thick and has an overburden of 4 to 6 feet of brown silt and silty sand.

*Area 20, east of Ottawa.*—A large terrace two miles east of Ottawa, at the mouth of Fox Valley in secs. 4, 5, 8, 9, T. 33 N., R. 4 E. (Rutland Twp.), Ottawa quadrangle, is underlain in part by deposits of gravel and sand (p. 169). The deposits are at least 25 feet thick in the east part of the terrace but thin westward and are locally absent near the west end of the terrace. The material varies from bouldery coarse gravel to fine gravel (app. D, table 6, W-16, DX-11) and is exposed along O'Neill branch in outcrops and in several small pits which have been worked for road gravel.

*Area 21, northeast of Ottawa.*—Outwash deposits of gravel underlie a low terrace in Illinois Valley at the mouth of Fox Valley one mile northeast of Ottawa, in the N. ½ sec. 6, T. 33 N., R. 4 E. (Ottawa Twp.), Ottawa quadrangle. The gravel is not exposed, so that its character is generally unknown, although many large well-rounded pebbles occur on the surface of the terrace. The gravel is reported to be 18 feet thick at the house near the center of sec. 6, but it apparently thins to the northeast, because it is locally absent at the margin of the terrace near Fox River where bedrock occurs at a shallow depth. Prospecting might reveal commercial deposits in this area which is along the Chicago, Burlington and Quincy Railroad.

*Area 22, northeast of Ottawa.*—Gravel and sand have been excavated from a pit half a mile northeast of Ottawa, at the mouth of Fox Valley, in the NW. ¼ NW. ¼ sec. 6, T. 33 N., R. 4 E., and in the NE. ¼ sec. 1, T. 33 N., R. 3 E. (Ottawa Twp.), Ottawa quadrangle. The pit has not been worked for a number of years and the material is poorly exposed. The upper part of the deposit is a fine sandy gravel (app. D, table 6, W-17), but the lower part is reported to consist of sand which was the principal material produced when the pit was operated. The deposit is about 30 feet thick and is overlain by 2 feet of silt and weathered gravel.

*Area 23, south of Ottawa.*—Sand and gravel occurs in a large area in the upland south of Ottawa, in secs. 18-20, T. 33 N., R. 4 E. (Fall River Twp.), and secs. 13-15, 22-26, T. 33 N., R. 3 E. (South Ottawa Twp.), Ottawa quadrangle. The deposits have been worked at a number of pits, principally for road gravel. They have a maximum thickness of about 50 feet at the west end of the area but are probably much thinner throughout most of the area, as the pits in secs. 19 and 13 are both shallow. The extent of the deposits was determined by auger borings which rarely penetrated more than a few inches of the deposits. Consequently it is not certain that deposits of workable thickness occur throughout the area mapped (pl. 2).

The deposits are deltas but differ from most deltas in the absence of clay balls. In pits in the west part of the area the material is a fine gravel (app. D, table 6, ML-130, ML-194). A bed of silt 1 to 2 feet thick occurs 5 to 10 feet below the top of the deposits in the pit of the South Ottawa Road Gravel Company in the SE. ¼ SW. ¼ SE. ¼ sec. 15, and also in a pit at the top of the Illinois Valley bluff in the NW. ¼ NE. ¼ NW. ¼ sec. 22. The materials below the silt bed have typical steeply dipping foreset bedding whereas those above are mostly cross-bedded. The exposed gravel contains a considerable amount of clay and silt which gives it good bonding properties for road surfacing, but the abundance of clay and soft materials such as sandstone and shale might make it difficult to produce a suitable aggregate for concrete.

*Area 24, southeast of Buffalo Rock.*—Outwash deposits of gravel and sand have been worked at several pits in a terrace one mile southeast of Buffalo Rock. The thickest and coarsest deposits occur at the east end of the area and have been largely worked out. The deposits are probably not of workable thickness throughout most of the terrace west of the pits. At the pit in the NW. ¼ NE. ¼ SE. ¼ sec. 20, T. 33 N., R. 3 E. (South Ottawa Twp.), Ottawa quadrangle, 5 feet of fine gravel (app. D, table 6, W-14) has an overburden of 1 to 2 feet of silt.

*Area 25, east of Buffalo Rock.*—A coarse cobbly gravel similar to that west of Buffalo Rock (Area 27) is reported to underlie a large area east of Buffalo Rock, on the south side of the main channel of Illinois River in secs. 17, 20, T. 33 N., R. 3 E. (South Ottawa Twp.), Ottawa quadrangle. The deposit is now largely inundated by the lake formed by the Starved Rock dam and could be worked only by dredging.

*Area 26, on Buffalo Rock.*—Fine-grained sand, mostly silty, occurs in a few low dunes on the top of Buffalo Rock, in the SE. ¼ sec. 18, T. 33 N., R. 3 E. (Ottawa Twp.), Ottawa quadrangle. The sand is brown and noncalcareous. It is probably not more than 10 feet thick and has an overburden of 1 to 2 feet sandy soil. Much of it has recently been stripped in mining the coal which occurs on the top of Buffalo Rock.

*Area 27, west and north of Buffalo Rock.* Outwash deposits of gravel underlie the floor of Illinois Valley west and north of Buffalo Rock, in secs. 18, 19, T. 33 N., R. 3 E. (Ottawa Twp.), and in secs. 13, 24, T. 33 N., R. 2 E. (Utica Twp.), Ottawa quadrangle. They are worked by the Moline Consumers Company at a plant in the NE. cor. sec. 19. The gravel is dug by a drag-line, mostly from below water-level, and is crushed, washed, and screened. The deposits are largely cobbly coarse gravel containing about 80 per cent gravel and 20 per cent sand (p. 173). The deposit is about 40 feet thick at Buffalo Rock but thins to the west.

Gravel is present at many places as far west as Utica, but bedrock generally occurs at a shallow depth, and it is doubtful if any of the deposits are thick enough to be of commercial importance except those at present worked near Buffalo Rock.

*Area 28, east of Utica.*—Two delta deposits occur on the upland north of Illinois Valley about a mile east of Utica, in sec. 10, T. 33 N., R. 2 E. (Utica Twp.), Ottawa quadrangle. The materials are exposed in several pits which have been worked for road gravel. In a pit in the NW. ¼ SW. ¼ SE. ¼ sec. 10 the material is a fine gravel (app. D, table 6, W-18) containing boulders and clay balls. The material in a pit in the NW. ¼ NE. ¼ SW. ¼ sec. 10 is a fine sandy gravel and pebbly sand. The deposits are from 10 to 30 feet thick and are overlain by about 4 feet of silt and weathered gravel.

*Area 29, south of Ottawa.*—Sand and gravel is at least locally present in the Covel Creek esker about four miles south of Ottawa, in secs. 1-5, T. 32 N., R. 3 E. (Farm Ridge Twp.), and secs. 5, 6, T. 32 N., R. 4 E. (Grand Rapids Twp.), Ottawa quadrangle (pl. 2). Where exposed in the railroad-cut in the SW. ¼ SW. ¼ NE. ¼ sec. 1 the fine gravel and pebbly sand is interbedded and overlain with till, and it is doubtful if the deposit can be worked, although this situation may not exist in all parts of the esker.

*Area 30, southeast of Lowell.*—A delta deposit of sand and gravel is exposed in a pit along the east side of a stream half a mile southeast of Lowell, in the NE. ¼ SW. ¼ NE. ¼ sec. 16, T. 32 N., R. 2 E. (Vermilion Twp.), Streator quadrangle. The material is a fine sandy gravel (app. D, table 6, ML-198) containing many cobbles and pink till balls and occurs in beds which dip steeply and uniformly northwest. The deposit is at least 30 feet thick and has an overburden of 3 to 4 feet of brown silt. The extent of the deposit is uncertain but a large quantity of gravel appears to be available adjacent to the present pit.

*Area 31, southeast of Lowell.*—A delta deposit of sand and gravel has been worked for road gravel in a pit east of Vermilion River, 1½ miles southeast of Lowell, in the SW. ¼ NW. ¼ SE. ¼ sec. 15, T. 32 N., R. 2 E. (Deer Park Twp.), Streator quadrangle. The material is a fine sandy gravel (app. D., table 6, ML-141), contains gray till balls and a few boulders, and occurs in beds which dip uniformly northwest. The deposit is about 15 feet thick and has an overburden of 3 to 5 feet clayey silt. This appears to be a small deposit, and most of it has been worked out.

*Area 32, northeast of Leonore.*—A delta deposit of gravel underlies a terrace along the south side of Vermilion Valley three miles northeast of Leonore, in the NE. ¼ SW. ¼ SE. ¼ sec. 23, T. 32 N., R. 2 E. (Vermilion Twp.), Streator quadrangle. The material is a fine gravel (app. D, table 6, J-17) but contains cobbles and beds of coarse gravel and coarse sand. It is 10 to 15 feet thick, has an overburden of 1 to 3 feet of silt and weathered gravel, and probably occurs in only a small area.

*Area 33, Vermilion Valley.*—Small deposits of gravel occur along Vermilion Valley in the Streator quadrangle in low terraces and in the channel of the river. The deposits are mostly too small to be of commercial importance, although material suitable for use on lanes and secondary roads probably occurs at several places. Gravel and sand usually occur at the inside of the bends in the river and could be worked on a small scale during intervals of low water.

*Area 34, southeast of Sandy Ford.*—A delta deposit of fine sandy gravel and pebbly sand (p. 160) underlies the upland area east of Vermilion Valley southeast of Sandy Ford, in the S. ½ sec. 5, T. 31 N., R. 3 E. (Bruce Twp.), Streator quadrangle. The gravel is 5 to 10 feet thick and has an overburden of 3 to 5 feet of silt where exposed in a pit in the SW. ¼ NW. ¼ SE. ¼ sec. 5. The deposit may underlie a considerable area in the south part of sec. 5. It has been used for surfacing secondary roads.

*Area 35, Cropsey moraine.*—Small local deposits of gravel and sand are probably present in the area of the Cropsey moraine in the Streator quadrangle but none are exposed. An auger boring at the Buffalo school three miles northwest of Long Point (app. A, geol. sec. 99) penetrated 3 feet 6 inches of pebbly sand below an overburden of silt of about equal thickness. The sand may be too thin to be workable.

*Area 36, Lake Pontiac plain.*—Thin local deposits of gravel and sand are present in the area of the Lake Pontiac plain in the Streator quadrangle (p. 169). Many auger borings in the lake plain penetrated sand or fine gravel below an overburden of 3 to 4 feet of silt. Gravel and sand is present in some of the low hills in the narrow area covered by the lake along Vermilion River northwest of Streator, and 9 feet of pebbly sand (app. D, table 6, ML-192) is exposed in a small pit in one of these deposits in the SW. ¼ SW. ¼ NE. ¼ sec. 26, T. 32 N., R. 2 E. (Vermilion Twp.).

*Area 37, northeast of Streator.*—Large delta deposits of gravel and sand occur along Otter Creek a short distance north and northeast of Streator in secs. 16-21, T. 31 N., R. 4 E. (Otter Creek Twp.), and secs. 13-15, 24, T. 31 N., R. 3 E. (Bruce Twp.), Streator quadrangle. They have been worked in several pits, and washed and screened sand and gravel was formerly produced at a pit in the SW. ¼ SW. ¼ SW. ¼ sec. 17. The deposit is a fine gravel (app. D, table 6, ML-132, J-16) at the pit of the Cephas Williams Gravel Company in the NW. ¼ NW. ¼ sec. 20. The material is poorly sorted and contains cobbles, boulders, and beds of sand. Till balls are locally abundant. The deposits are locally at least 25 feet thick, but they are variable in thickness and are thinner in most of the area. The overburden is about 3 feet of clayey silt. Prospecting by digging pits or drilling is necessary to determine how far the deposits extend back from the outcrops. Small deposits of gravel and sand also occur in low terraces along Otter Creek.

*Area 38, Chatsworth moraine.*—Small deposits of gravel and sand are probably present at some places in the area of the Chatsworth moraine in Streator quadrangle but none are exposed.

*Area 39, southeast of Streator.*—Gravel for use on local roads has been produced from a pit on the west bank of Vermilion River half a mile northwest of Manville Bridge four miles southeast of Streator, in the NW. ¼ NE. ¼ SW. ¼ sec. 19, T. 30 N., R. 4 E. (Newtown Twp.), Streator quadrangle (app. A, geol. sec. 92). The material is a fine sandy gravel (app. D, table 6, J-8) but is poorly sorted. It is a delta deposit containing many cobbles, boulders, large till balls, and beds of sand and silt. The deposit is about 20 feet thick. It has an overburden of till which is thin at the pit but probably increases in thickness in the adjacent area.

## NATURAL-BONDED MOLDING SAND

Several deposits of sand in the Marseilles-Ottawa-Streator area may be suitable for natural-bonded molding sand. Although natural-bonded molding sand has not been produced in the area, large quantities of silica sand (p. 234) from the St. Peter sandstone have been used for steel-molding and core sand.

The area contains many deposits of glacial sands but they are mostly calcareous and do not contain enough clay to bond the sand. Where the glacial sands are weathered the carbonates have been leached, and bonding material has been added to the upper part of the sand by the infiltration of clay from the surface zone. The weathered sand is mostly reddish-brown, clayey, sticky when wet, slightly coherent when dry, and noncalcareous. It is usually overlain by 1 to 3 feet of dark brown or gray sandy soil and grades downward into light gray, yellow, or brown calcareous sand. In these quadrangles the noncalcareous zone is usually 3 to 4 feet thick but locally is 6 to 7 feet thick. The noncalcareous zone commonly does not contain sufficient clay to bond the sand. In most deposits the lower part is weakly bonded.

### RESOURCES

The deposits which may be used for natural-bonded molding sand are briefly described below. Before attempting to develop any of these deposits, test-pits should be dug to determine the size of the deposits, and samples should be tested to determine the quality of the sand.

*South and southeast of Seneca.*—Deposits of brown noncalcareous sand are exposed in several shallow gullies on the terrace south and southwest of Seneca (Area 9, p. 267). A sample from 6 feet of brown clayey medium-grained sand exposed along Spring Brook in the NW. ¼ SE. ¼ NE. ¼ sec. 34, T. 33 N., R. 5 E. (Brookfield Twp.), Marseilles quadrangle, was reported to be a medium quality sand for gray-iron castings if the grains of limestone and dolomite are kept below 1½ per cent (table 13). The limestone and dolomite grains probably occur only in the lower part of the interval sampled, and this part could be omitted in working the deposit. The sand is also exposed at the east end of the terrace near the top of the valley-wall in the NE. ¼ SE. ¼ NE. ¼ sec. 35 and is 2 to 4 feet thick.

*Northeast of Serena.*—Brown fine-grained sand occurs in dunes on a terrace two miles northeast of Serena, on the east side of Fox Valley, in the N. ½ sec. 20, T. 35 N., R. 5 E. (Mission Twp.), Marseilles quadrangle. The sand is more extensive a short distance north of the quadrangle. Locally as much as 6 feet of the sand is noncalcareous but it is low in bond. Some of it may be suitable for core sand.

*North of Wedron.*—Many of the low terraces along Indian Creek, north of Wedron, are underlain by 1 to 4 feet of brown medium-grained sand, some of which may be suitable for molding sand. It is exposed along the stream in the SW. ¼ SE. ¼ SW. ¼ sec. 33, T. 35 N., R. 4 E. (Serena Twp.), Ottawa quadrangle.

*East of Dayton.*—A low terrace along the east side of Fox Valley east of Dayton, in secs. 29, 32, T. 34 N., R. 4 E. (Rutland Twp.), Ottawa quadrangle, is underlain by 6 feet of brown medium-grained noncalcareous sand. The deposit overlies the St. Peter sandstone. The upper 2 to 4 feet of the sand may be suitable for molding sand although it is weakly bonded. The lower part especially contains little bond.

TABLE 13.—MOLDING SAND TEST[a]

Sample from outcrop two miles southwest of Seneca, along Spring Brook, NW. ¼ SE. ¼ NE. ¼ sec. 34, T. 33 N., R. 5 E. (Brookfield Twp.), Marseilles quadrangle.

| | Test 1 | Test 2 |
|---|---|---|
| Moisture, per cent | 6 | 8 |
| Cohesiveness, grams | 261 | 200 |
| Saeger compression, pounds | 7.2 | 5.8 |
| Permeability | 223 | 140 |
| Grain size, retained on | Mesh | Per cent |
| | 6 | .4 |
| | 10 | .2 |
| | 20 | 1.5 |
| | 28 | 3.8 |
| | 35 | 13.3 |
| | 48 | 32.5 |
| | 65 | 21.1 |
| | 100 | 11.5 |
| | 150 | 2.9 |
| | 200 | 1.6 |
| | 270 | .9 |
| | Pan | 2.2 |
| | Clay and silt | 8.1 |

Recommended use: Very sticky when wet. Forms hard balls when dry. Contains limestone and dolomite grains. If these grains can be kept below 1½ per cent, the sand will probably be a medium quality sand for gray-iron castings.

[a]Test by Mechanical Engineering Department, University of Illinois, for Illinois Geological Survey.

## LIMESTONE AND DOLOMITE

The Marseilles-Ottawa-Streator area contains deposits of limestone, magnesian limestone, and dolomite. A small quantity of limestone has been produced from several quarries, none of which have been worked for many years. Some of the deposits could supply local needs for agricultural limestone or road metal but it is doubtful if any of the deposits are large enough or are favorably situated for large-scale development. At present the local requirements are being supplied by larger deposits in the adjacent areas. Magnesian limestone is quarried at Central about 3½ miles east of the northeast corner of the Marseilles quadrangle; limestone is quarried at Pontiac about eight miles southeast of the Streator quadrangle; and limestone is produced at LaSalle and dolomite at Troy Grove, both about four miles west of the Ottawa quadrangle.

Limestone occurs in the Pennsylvanian strata in thin beds which do not exceed 6 feet in thickness and are only locally more than 2 feet thick. The Platteville and Decorah formations consist of thick deposits of limestone, magnesian limestone, and dolomite which are intermixed and cannot be worked separately. Dolomite, argillaceous dolomite, and cherty dolomite, in part interbedded with sandstone, occur in thick deposits in the Shakopee dolomite.

### RESOURCES

The resources of limestone and dolomite in the quadrangles are not large. Many of the deposits in the area are poorly located with reference to transportation, have a thick overburden, or are small, but some of them can possibly be worked for small quantities of stone for local use, and they may become of increased value with exhaustion of other deposits. The locations of the areas described are shown in figure 125.

*Area 1, west of Ottawa.*—The Platteville limestone underlies part of the terrace west of Ottawa, on the north side of Illinois Valley, in sec. 16, T. 33 N., R. 3 E. (Ottawa Twp.), Ottawa quadrangle (pl. 2). The limestone varies from a few inches to as much as 20 feet thick. In part of the area mapped it consists of only a discontinuous layer of boulders of limestone and is probably too thin to be worked. It is thickest near the Libby-Owens-Ford glass factory at the south end of the area, where a small quarry was formerly operated. The most favorable area for development is west of the factory in the central and south part of sec. 16. The limestone is exposed in the overburden of a sand pit and consists of 12 feet of slightly cherty mottled limestone and dolomite (fig. 39). It locally occurs directly below the soil but the upper surface contains clay-filled pockets and channels 2 to 4 feet deep. The rock is broken by vertical clay-filled joints. A physical test (table 14, No. 1559) shows the stone has a low per cent of wear, and it probably can meet specifications for concrete aggregate if clay from the clay pockets is kept out of the crushed stone. The stone is similar in appearance to that along Covel Creek (Area 2), an analysis of which indicates that it is relatively high in carbonates and suitable for agricultural limestone. The area is crossed by a switch of the Chicago, Rock Island and Pacific Railroad and its southern end is along the Illinois Waterway.

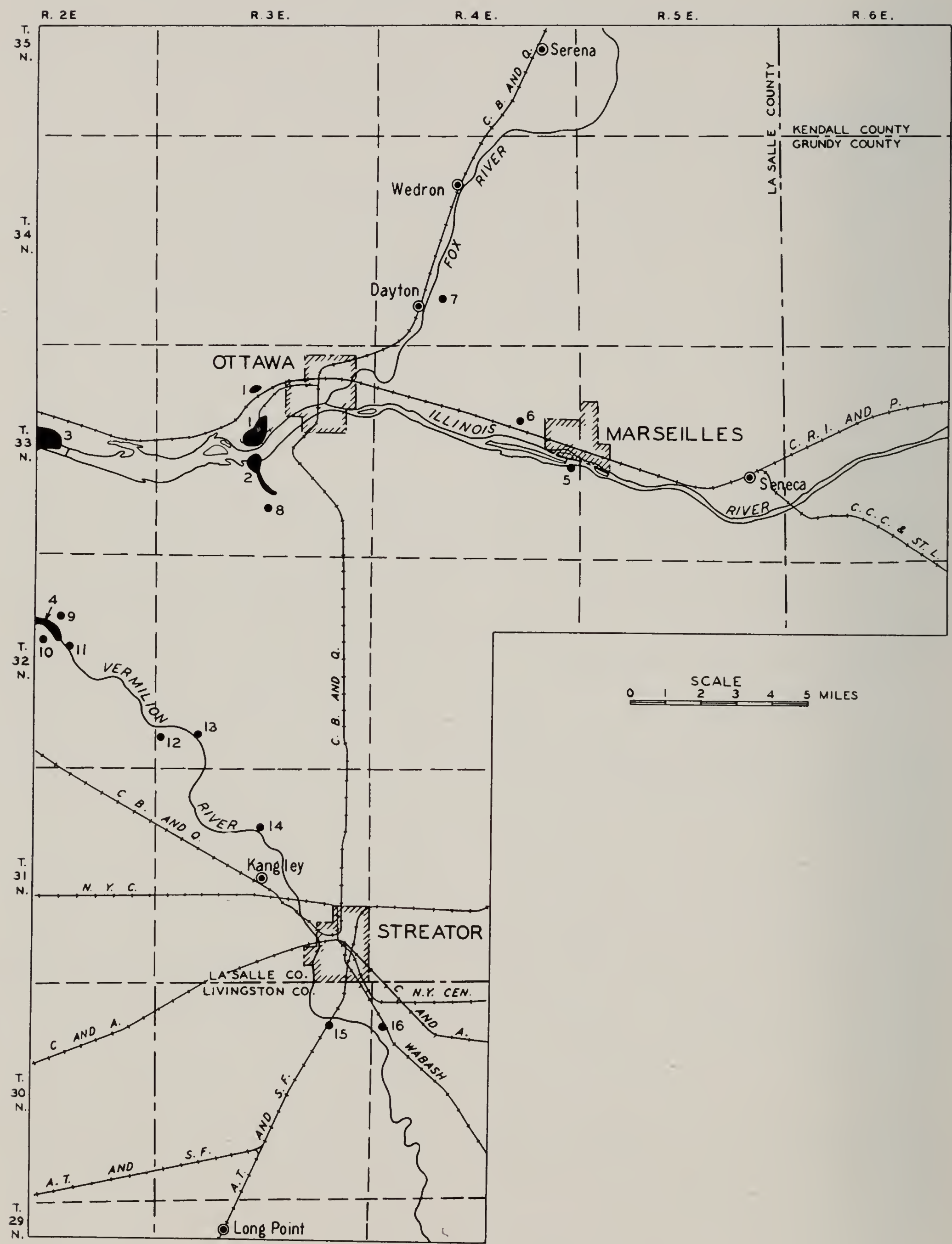



FIG. 125.—Locations of limestone and dolomite deposits.

Table 14.—Physical Tests of Limestone

| | | |
|---|---|---|
| Sample No. | W-80[a] | 1559[b] |
| Material | Platteville | Platteville |
| Specific gravity | 2.68 | 2.73 |
| Absorption (per cent) | .8 | .3 |
| Per cent of wear | 3.3 | 4.4 |
| French coefficient | 12.1 | 9.1 |
| Toughness | | 7.0 |
| Sodium sulphate soundness test— | OK after 5 days. | |

[a]Sample W-80 was collected from 15 feet of Platteville limestone exposed along Covel Creek, NW. ¼ SE. ¼ sec. 21, T. 33 N., R. 3 E. (South Ottawa Twp.), Ottawa quadrangle. It was tested by the Illinois Division of Highways, for the State Geological Survey.

[b]Sample 1559 from the quarry (now abandoned and filled), SE. ¼ sec. 16, T. 33 N., R. 3 E. (Ottawa Twp.), Ottawa quadrangle. Fifth report of the Illinois State Highway Department, p. 254, 1917.

*Area 2, southwest of Ottawa.*—The Platteville limestone (p. 80) also underlies part of the terrace at the mouth of Covel Creek two miles southwest of Ottawa, and it crops out along Covel Creek for about three quarters of a mile upstream from Illinois Valley, in secs. 21, 27, 28, T. 33 N., R. 3 E. (South Ottawa Twp.), Ottawa quadrangle (pl. 2). About 15 feet of limestone is exposed but its maximum thickness is probably about 20 feet. A sample representing 13 feet of limestone exposed along Covel Creek about 100 yards above the mouth of the valley, was a magnesian limestone containing 95 per cent carbonates (app. H, table 1, W-80). A physical test of this sample showed it had a low per cent of wear (table 14, W-80). In the terrace in Illinois Valley the limestone could possibly be quarried in an area of about 40 acres, although it is not certain that the limestone is of workable thickness throughout the area. It has a thin overburden of soil and silt. Covel Creek has a narrow bottomland and there is space for only small quarries along the creek. The area is about a mile from the Chicago, Burlington and Quincy Railroad, is crossed by State Highway 71, and is adjacent to Illinois Waterway.

*Area 3, southeast of Utica.*—The Shakopee dolomite underlies Illinois River and the neighboring bottomlands along the west margin of the Ottawa quadrangle, north of Starved Rock, in the SW. ¼ sec. 15, SE. ¼ sec. 16, T. 33 N., R. 2 E. (Utica Twp.), Ottawa quadrangle. The strata are not exposed but were penetrated in test-drilling near the site of the Starved Rock lock and dam, and some of the dolomite was blasted out in excavating for the foundations of the lock and dam. The top of the dolomite is below the level of Illinois River throughout the area, and more favorable quarry sites occur west of the Ottawa quadrangle in the LaSalle quadrangle. The dolomite has an overburden of from 10 to 25 feet of silt, sand, and gravel, except in part of the river channel where it occurs directly below the water. Some of the borings showed beds of sandstone and shale in the dolomite, but in others the material is reported as all dolomite. The strata probably have the same character as in outcrops in the north bluff of Illinois Valley a short distance west of Utica, where they are highly variable and consist of beds of dolomite, cherty dolomite, argillaceous dolomite, sandstone, and chert. The beds of argillaceous dolomite used in the manufacture of natural cement at Utica may be present in this area, but the upper bed is probably at least 50 feet below the top of the formation. Analyses of samples[12] of the Shakopee collected near Utica show that the formation contains 75 to 85 per cent carbonates and the remainder is largely silica.

*Area 4, at Lowell.*—The Decorah limestone crops out along Vermilion River at Lowell, in the SE. ¼ sec. 9, NE. ¼ sec. 16, T. 32 N., R. 2 E. (Deer Park Twp.), Ottawa quadrangle, and in the NE. ¼ sec. 16, T. 32 N., R. 2 E. (Deer Park Twp.), Streator quadrangle. The best exposures of the Decorah limestone and the overlying Galena limestone and the most favorable quarry sites occur just west of the Ottawa quadrangle in the LaSalle quadrangle. The strata consist of limestone, magnesian limestone, and dolomite (p. 82). A sample[13] representing 50 feet of the strata at Lowell contained only 0.60 per cent silica and 43.85 per cent carbon dioxide, which indicates it probably contained over 95 per cent carbonates. The limestone is probably 200 feet or more thick. The maximum thickness of the beds above the level of the river at any one place is about 15 feet, but because of their westward dip a total of about 150 feet of the strata is exposed, including

[12]Lamar, J. E., Willman, H. B., Fryling, C. F., and Voskuil, W. H., Rock wool from Illinois mineral resources: Illinois Geol. Survey Bull. 61, samples DS-18, DX-19, DS-57, pp. 142, 143, 1934.

[13]Lamar, J. E., and others, op. cit., sample DS-63, pp. 142, 143.

the outcrops in LaSalle quadrangle. In the valley-walls the limestone has an overburden of Pennsylvanian strata and glacial drift mostly over 25 feet thick. As the valley-bottoms are narrow and all except narrow terrace areas are covered by the river in flood stages, the area is not favorable for the development of a large quarry. Small quarries might be operated in the low terraces to produce stone for local use, especially agricultural limestone. The area is crossed by State Highway No. 178, and a branch of the Chicago, Burlington and Quincy Railroad extends to Lowell within half a mile.

*Areas 5-16.*—Thin beds of Pennsylvanian limestone crop out in all three quadrangles. Most of the limestones are slightly argillaceous and some of them grade into highly argillaceous limestone. These limestones are usually less than 2 feet thick and the thickest is only 6 feet thick. As most of the outcrops are along steep-sided valleys the amount of stone available with a thin overburden is not large at any one outcrop. However, some of the outcrops might be worked as a local source of agricultural limestone, and those in which the beds are about 2 feet or more thick are listed below.

*Marseilles quadrangle*

5.—South side Illinois River near Marseilles bridge, SE. ¼ NW. ¼ NE. ¼ sec. 24, T. 33 N., R. 4 E. (Fall River Twp.).

6.—Along Walbridge Creek south of highway, NW. ¼ NE. ¼ NW. ¼ sec. 14, T. 33 N., R. 4 E. (Rutland Twp.).

*Ottawa quadrangle*

7.—Along stream, near center SW. ¼ sec. 28, T. 34 N., R. 4 E. (Rutland Twp.).

8.—Along stream east of road, NW. ¼ SW. ¼ sec. 27, T. 33 N., R. 3 E. (South Ottawa Twp.).

9.—Along stream, center SW. ¼ sec. 10, T. 32 N., R. 2 E. (Deer Park Twp.).

*Streator quadrangle*

10.—Along stream, NW. ¼ SE. ¼ NE. ¼ sec. 16, T. 32 N., R. 2 E. (Vermilion Twp.).

11.—Along stream, SE. ¼ NE. ¼ SE. ¼ sec. 15, T. 32 N., R. 2 E. (Deer Park Twp.).

12.—Along stream, NW. ¼ sec. 31, T. 32 N., R. 3 E. (Vermilion Twp.).

13.—East bluff Vermilion River, NW. ¼ NW. ¼ sec. 32, T. 30 N., R. 3 E. (Farm Ridge Twp.).

14.—Above slumped mine-entry, NE. ¼ SE. ¼ SE. ¼ sec. 9, T. 31 N., R. 3 E. (Bruce Twp.).

15.—Road-cut, NW. ¼ NE. ¼ NE. ¼ sec. 11, T. 30 N., R. 3 E. (Reading Twp.).

16.—Along stream and in southeast cut in the pit of the Streator Clay Products Company, NW. ¼ NW. ¼ sec. 7, T. 30 N., R. 4 E. (Newtown Twp.).

## SANDSTONE

Sandstone crops out at many places in the Marseilles-Ottawa-Streator area. The principal sandstones are the St. Peter sandstone of Ordovician age and the Pleasantview, Vermilionville, Copperas Creek, and Gimlet sandstones of Pennsylvanian age. The St. Peter sandstone is the source of "silica sand" which is described elsewhere (p. 234) and is generally not solid enough to be quarried in blocks.

The Pennsylvanian sandstones can be quarried in blocks although they are only a little more solid than the St. Peter sandstone. They are fine-grained, silty, and micaceous. The beds range irregularly from very thin laminae to massive beds 5 feet or more thick. Much of the sandstone is gray on fresh surfaces but weathers light buff speckled with small brown spots and locally with rusty streaks. The deposits are commonly 20 feet thick and locally they are 50 feet or more thick. Their character is described in detail in the chapter on stratigraphy.

A small quantity of the Pennsylvanian sandstones has been quarried mostly for use as foundation stone for nearby farm buildings, but none of the quarries have been worked for some years. Some massive beds of the Vermilionville sandstone were formerly quarried about two miles east of Ottawa, in the NE. ¼ NW. ¼ SE. ¼ sec. 17, T. 33 N., R. 4 E. (Fall River Twp.), Ottawa quadrangle.

The sandstones are mostly too soft to be widely used for building stone other than in small structures where low cost is essential and the sandstone is conveniently close. Although much of the massive stone is free-working and easily shaped, it is difficult to produce sound blocks because of the ease with which the rock fractures. However, the surface of the sandstone becomes harder due to the effect of weathering, and consequently the sandstone is more effective as a building stone than might be expected from its softness. Some of the medium-bedded sandstone which weathers into slabs might be used in house or garden-wall construction where a rustic effect is desired, but the bedding of the deposits is probably not sufficiently uniform to permit a large-scale development for this use.

Typical outcrops of the massive sandstone are common at many places along Vermilion River, in Illinois Valley bluffs near Marseilles and southeast of Ottawa, and in the valley-bottoms at Seneca. A few localities where the sandstone occurs below a thin overburden are as follows:

Illinois Valley terrace south and east of Seneca, especially in secs. 15, 16, 19, 20, T. 33 N., R. 6 E. (Erienna Twp.), secs. 24-26, T. 33 N., R. 5 E. (Manlius Twp.), Marseilles quadrangle.

South bluff of Illinois Valley, center sec. 18, T. 33 N., R. 4 E. (Fall River Twp.), Ottawa quadrangle.

South bluff of Illinois Valley west of Covel Creek, secs. 21, 28, T. 33 N., R. 3 E. (South Ottawa Twp.), Ottawa quadrangle.

East bluff of Vermilion Valley north of Sandy Ford, SE. ¼ sec. 32, T. 32 N., R. 3 E. (Farm Ridge Twp.), Streator quadrangle.

Near mouth of stream on east side of Vermilion River, NW. ¼ NE. ¼ sec. 18, T. 30 N., R. 4 E. (Newtown Twp.), Streator quadrangle.

West bluff of Vermilion River, NW. ¼ sec. 18, T. 30 N., R. 4 E. (Newtown Twp.), Streator quadrangle.

The medium-bedded sandstone is exposed at the following localities:

West bluff of Vermilion River, NW. ¼ sec. 15, T. 31 N., R. 3 E. (Eagle Twp.), Streator quadrangle.

East bluff of Vermilion Valley, SW. ¼ SW. ¼ sec. 23, T. 31 N., R. 3 E. (Bruce Twp.), Streator quadrangle.

## PEAT

Deposits of peat occur at several places on the terraces in Illinois Valley and are locally present in small depressions in the upland areas. The peat is mostly dark brown to nearly black and consists of partly decomposed grasses, sedges, and mosses. Probably most of the deposits are less than 5 feet thick although those in the swampy areas near Utica may be somewhat thicker. None of the deposits have been worked commercially.

Some of the peat may be suitable for use in the beneficiation of soils low in content of organic matter. Peat improves the working qualities of certain clayey soils, and in sandy soils the moisture-retaining properties of the peat improves the resistance to drought. The market for peat would probably be mostly for lawns or gardens, especially where the natural soils have been covered in filling in the lots.

The extent of the peat deposits has been determined by the Soil Survey[14] by auger borings. Careful prospecting should precede attempts to develop any of the deposits, as in some cases where peat swamps have been drained and cultivated, oxidation of the peat and admixture of inorganic constituents has altered the deposits until they can no longer be classified as peat. Deposits more than 30 inches thick are reported at the following localities:

Southwest of Seneca, SW. ¼ NW. ¼ sec. 27, SE. ¼ NE. ¼ sec. 28, SE. ¼ sec. 28, NE. ¼ NE. ¼ sec. 33, and N. ½ NW. ¼ sec. 34, T. 33 N., R. 5 E. (Brookfield Twp.), Marseilles quadrangle.

West of Ottawa along the Illinois and Michigan Canal through sec. 9 and southeast of the canal in the NE. ¼ NW. ¼ sec. 16, T. 33 N., R. 3 E. (Ottawa Twp.), Ottawa quadrangle.

East of Utica in a belt roughly a quarter of a mile wide through the central part of the S. ½ sec. 14 and SE. ¼ sec. 15, T. 33 N., R. 2 E. (Utica Twp.), Ottawa quadrangle, now partly submerged by backwater from the Starved Rock dam.

North of Leonore, SW. ¼ NW. ¼ and N. ½ SW. ¼ sec. 27, T. 32 N., R. 2 E. (Vermilion Twp.), Streator quadrangle.

[14]Hopkins, C. G., Mosier, J. G., Pettit, J. H., and Readhimer, J. E., LaSalle County soils: Univ. of Illinois Agr. Exp. Sta. Soil Report No. 5, 1913.

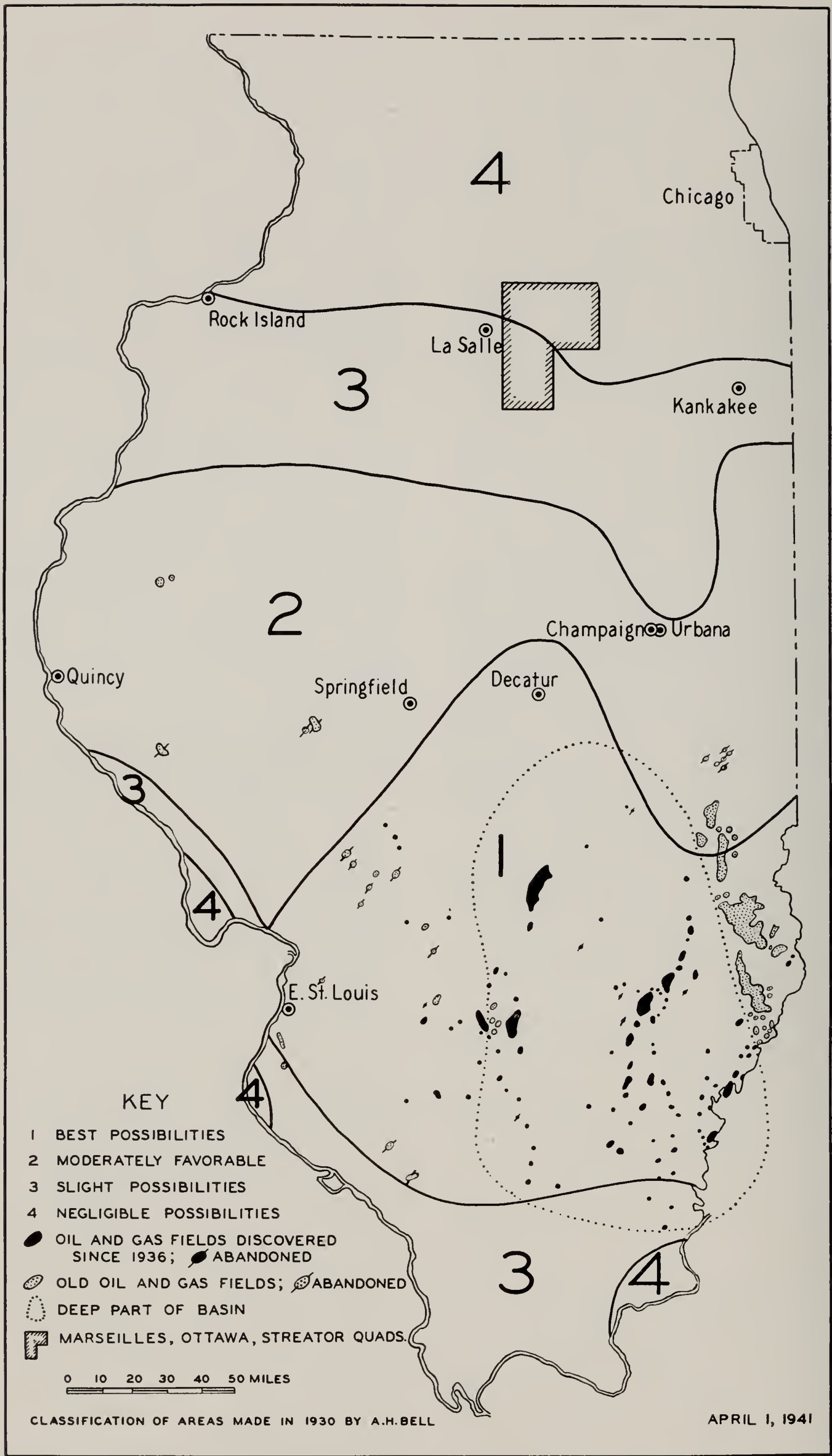



FIG. 126.—Classification of oil and gas possibilities of Illinois and locations of oil and gas pools. (Revised from Illinois Geological Survey Circular 64, fig. 2, 1940.)

## OIL AND GAS POSSIBILITIES

No oil or gas has been produced in the Marseilles-Ottawa-Streator area. Several oil-test wells and deep water wells have been drilled in the area but none reported even a show of oil or gas. Small pockets of gas have been found in shallow water wells in the glacial drift in neighboring areas and probably some water wells in this area have encountered similar gas accumulations. Sufficient gas to supply farm homes for some years may be locally found but quantities of commercial importance are rarely present in the drift. The nearest production of oil was at Herscher, about 40 miles east of Streator, where a very small production was obtained from the Galena-Platteville formations.

The greater part of the Marseilles-Ottawa-Streator area occurs in that portion of Illinois where the possibilities of discovering commercial quantities of oil are negligible, and the remaining part in that portion where the possibilities are only slight (fig. 126). This classification is based on the relative abundance of known oil-bearing formations and the possibility of favorable conditions for the accumulation of oil.

### OIL-PRODUCING FORMATIONS

The formations in this area which have produced oil elsewhere in Illinois are the Galena-Platteville and Niagaran formations and the Pennsylvanian sandstones. No commercial production has been found in this part of the country in the St. Peter or older formations and therefore the oil possibilities are negligible in the part of the area where this formation crops out, directly underlies the drift, or is overlain by thin Galena-Platteville or Pennsylvanian strata. This includes all of the Ottawa quadrangle except the extreme south part and most of the west half of the Marseilles quadrangle.

The Galena-Platteville strata, frequently called "Trenton", are locally a source of commercial oil production in Illinois, but in the Marseilles-Ottawa-Streator quadrangles their oil possibilities are considered negligible in those areas where they directly underlie the drift. If they are less than 50 feet thick their possibilities are also negligible even though they are overlain by Pennsylvanian strata. Where they are thick and overlain by impervious bedrock strata, the upper Galena-Platteville strata are the most favorable for oil production in the quadrangles, especially in view of the small production at Herscher. However, as the Galena-Platteville strata in all parts of the area are near outcrops where any oil could have escaped, and because of the general lack of oil production from these strata in this part of the State, their possibilities in the Marseilles-Ottawa-Streator area are only slight.

In the southwest part of the Streator quadrangle the Maquoketa shale and limestone and the Niagaran dolomite are present although not exposed. The Maquoketa strata are not known to be oil-bearing in Illinois, but the Niagaran dolomite is productive elsewhere in the State, and it contains highly viscous or solid bitumens at many outcrops in northern Illinois. The Niagaran is a potential oil-producing formation, but as it has not yielded oil in commercial quantities in northern Illinois its possibilities in these quadrangles are only slight.

Although Pennsylvanian sandstones have produced oil in southern Illinois, no oil has been found in these beds in northern Illinois. All of the Pennsylvanian sandstones in this area are relatively fine-grained and argillaceous and are therefore not especially favorable for oil accumulation. As all of these sandstones crop out in this region, and no traces of oil have been found in them although they have been penetrated by water wells at many places, their possibilities for oil production are considered negligible.

### STRUCTURES

Another important factor in determining the probability of the presence of commercial quantities of oil is the occurrence of structural conditions favorable for its accumulation. Indiscriminate drilling of oil-tests without regard to structure of the rocks meets with failure in a very high percentage of cases, even in areas where possible oil-bearing strata are present. Commercial quantities of oil are most commonly found in porous strata called "reservoirs", such as sandstones or vesicular limestones or dolomites, at places where they are overlain by impervious "caprocks" such as shale. Where these strata are tilted or folded, oil which "migrates" or is forced by the movement of water and gas into or along the reservoir rock is trapped below the impervious caprock and above water in the structurally high areas of the reservoir rocks, such as anticlines, domes, etc. Such structures are generally the most favorable places for testing for oil.

The largest anticline in the Marseilles-Ottawa-Streator area is the LaSalle anticline (p.183) which crosses the west part of the Streator quadrangle and lowers or plunges southeast (fig. 102). Because of this plunge any oil migrating in the structure would move northwesterly up the slope of the structure and might be expected to escape where the reservoir rocks are exposed, unless the oil is trapped along the anticline at a reversal of the slope. The data available are not sufficient to demonstrate either the presence or absence of any such reversals in dip along the LaSalle anticline in the Streator quadrangle. An oil-test well near the axis of the anticline at Lowell did not find oil, but this may have been because the well was drilled almost on the outcrop of the Galena-Platteville formations. Also a test-boring three miles west of Long Point, near the southeast corner of sec. 2, T. 29 N., R. 2 E. (Groveland Twp.), Streator quadrangle, which was probably only a short distance west of the axis of the anticline, was drilled to the St. Peter sandstone and did not find oil.

The structure map of LaSalle (No. 2) coal (pl. 12) shows several anticlines in the Pennsylvanian beds which are probably also present in the underlying strata (p. 187). Of these the most prominent is the Dwight anticline (fig. 102 and pl. 12) which crosses the Marseilles quadrangle in a general northwest-southeast direction and plunges southeast. In the north part of the quadrangle the Galena-Platteville formations are very thin or absent, and no other formation productive of oil elsewhere in the region is present. The formations thicken southward and are locally as much as 280 feet thick south of Illinois Valley. However, the data available do not show any reversal in the direction of the plunge of the anticline, and several water wells which passed completely through the Galena-Platteville strata on the structure did not encounter oil.

Oil also occurs in structural situations resulting from the overlap of impervious strata on the eroded ends of tilted reservoir rocks. Such a structural condition occurs along the west slope of the La-Salle anticline in the southwest part of the Streator quadrangle, where the Galena-Platteville, Maquoketa, and Niagaran formations are overlapped by Pennsylvanian strata (pl. 13). The Galena-Platteville strata, which are overlain by impervious Maquoketa shale where not overlapped by the Pennsylvanian, and the Niagaran dolomite are the most favorable strata for oil accumulation in this situation. Nevertheless, the test-well three miles west of Long Point penetrated the overlap where the Pennsylvanian strata overlie Maquoketa strata and did not find oil in the underlying Galena-Platteville formations. However, the exact position of the overlap of the Pennsylvanian strata on the Galena-Platteville and Niagaran formations is not accurately known, so exploratory drilling would probably be necessary to locate the position of the overlap and any desirable structures along it. Whether or not geophysical methods, as for example the reflection seismograph, would yield the desired information is doubtful. Although this part of the quadrangles is probably the most favorable, the general conditions even here are such that there are only slight possibilities for oil.

## GROUNDWATER AQUIFERS

By
J. Norman Payne

*Introduction.*—Groundwater for industrial, municipal, or domestic purposes in north-central Illinois is available in all the formations present in the area (fig. 31). Large supplies for industrial and municipal purposes may be obtained from Pleistocene sand and gravel deposits and from the Galena-Platteville, St. Peter, New Richmond, Galesville, Eau Claire, and Mt. Simon formations. Smaller supplies for domestic use may be obtained from rocks of the Pennsylvanian and Silurian systems and from the Maquoketa, Shakopee, Oneota, Jordan, Trempealeau, and Franconia formations.

Every one of the formations above the Trempealeau is absent in some part of the region, and elsewhere ranges up to its maximum thickness as a result of uplift and erosion at various times (pp. 192-195, pls. 14, 16, 17, 18, 20, 21, 23, 25, 27).

The New Richmond and younger formations crop out somewhere in the region, so that the depth to the respective formations varies from zero to the maximum depth to which the structural depressions in the region carry them (pls. 15, 19, 22, 24, 26). The approximate depth to any aquifer at any point in the region may be calculated by subtracting the elevation of the aquifer from the surface elevation at that point.

The structures of the region not only determine the distribution and thickness of, and the depth to, the aquifers, but they also affect the flow of water through the aquifers and the chemical characters of the water in them. Groundwater naturally tends to flow downward, but in a confined aquifer—that is, one that is overlain and underlain by relatively impervious strata—this tendency may be overbalanced, and the water will be forced to flow up-dip on one side of a syncline when there is a higher "head" or greater amount of water in the aquifer on the other side of the syncline. In such a situation the flow of the water in the aquifer may be mainly through the upper part of the formation across the syncline, so that in the lower part of the formation in the deepest part of the syncline the water may be relatively stagnant and for two reasons may be more highly mineralized than elsewhere in the formation: (1) If the structures were formed soon after deposition of the formation and before a flow of groundwater had developed through the formation, the connate water (the seawater included in the interstices of the formation when it was being deposited) may have never been flushed out. (2) Mineralized groundwater, like the saline connate water, is heavier than fresh water and would tend to settle and remain in the deepest part of the structural basins.[15]

Other factors affecting the flow of groundwater are the size and sorting of grains in sands and sandstones, the amount of interstitial material, such as clay and the carbonates of calcium and magnesium, and the number, size, and continuity of cavities in limestones and dolomites, and the continuity of the water-bearing stratum. For instance, in a sandstone in which the grains are of large and uniform size water moves more freely than in a sandstone in which the grain size is highly variable or in one in which clay, dolomite, or calcite partially fills the interstices.

The groundwater available in the higher aquifers probably enters them locally, or at least in northern Illinois, where the formations crop out or lie directly under glacial drift so that the rainfall can percolate down into the formations. However, most of the groundwater in the formations older than the Oneota dolomite is derived from areas in Wisconsin where these formations crop out or lie directly under glacial drift (fig. 127). The water is carried from the areas of infiltration to north-central Illinois because of the general southward dip of the formations and because they are overlain by relatively impervious beds through which the water cannot escape. The pressure of water in the confined aquifer produces the "head", or the height to which the water will rise in a well which penetrates the aquifer. This head is determined by the ground-surface elevation in the collecting area reduced by the effect of friction in the formation and by withdrawal by pumpage or natural flow. Locally, where the head

[15]Information concerning the mineral content and also the temperature and yields of water from wells in Illinois may be obtained from the State Water Survey, Urbana, Illinois.

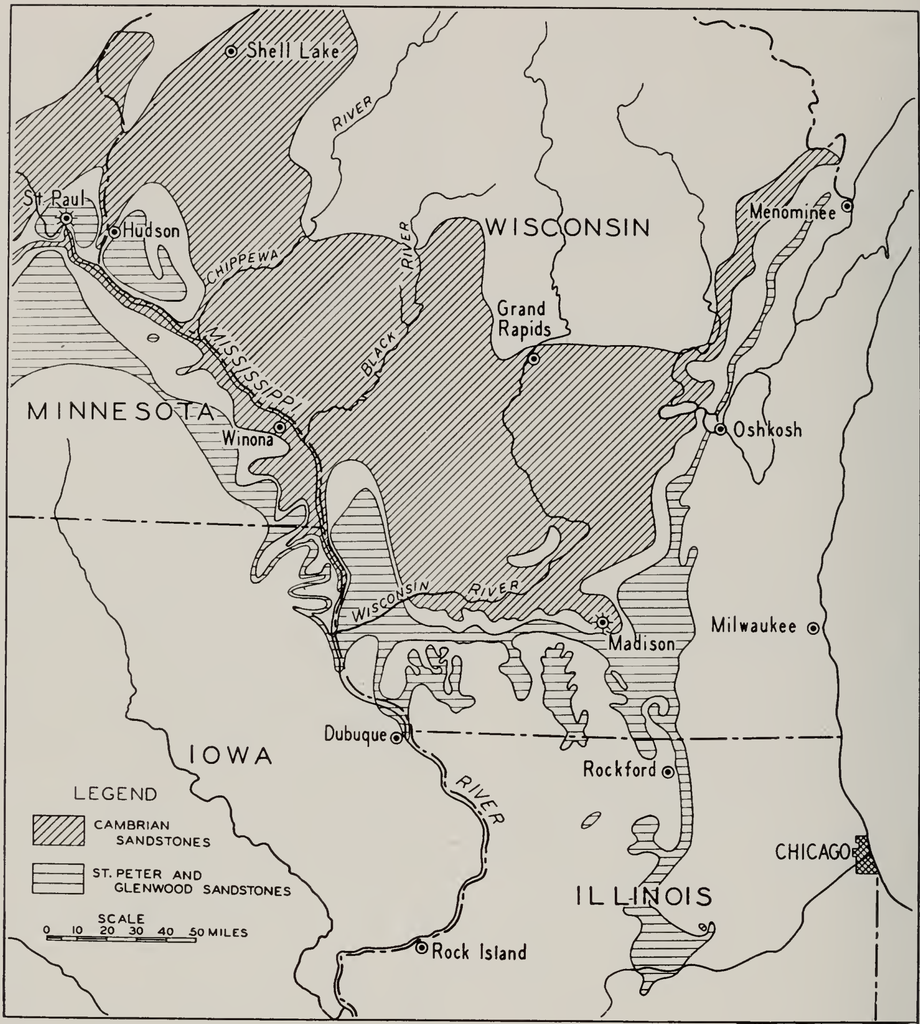



FIG. 127.—Subglacial surficial distribution of Cambrian, St. Peter, and Glenwood sandstones in Wisconsin and parts of adjacent states. (Generalized compilation from current State geological maps.)

is higher than the ground surface, the water flows from wells, or where the formation crops out the water flows from springs. Local structures as well as regional structures cause artesian head or flow.

Some springs occur where joints or fractures in the overlying rocks provide avenues by which the water can rise to the surface. However, most of the springs in the region are the result simply of local rainfall soaking down into the ground until it encounters a relatively impervious stratum along which it tends to move laterally and issues as seeps or springs along valleys.

## CAMBRIAN SYSTEM

*Mt. Simon formation.*—Large quantities of water are probably available in the Mt. Simon formation, although up to the present time no municipal, industrial, or domestic supplies in north-central Illinois have been obtained from it. It may be an especially important aquifer along the Kankakee arch in southern DeKalb, northern LaSalle, and eastern Lee counties, where it lies at depths of only 600 to 1000 feet (pls. 13-28). On account of the LaSalle and Kankakee anticlines, the formation lies at shallower depths in the central and north-central parts of the region than in the east, south, and west parts.

Its water-bearing capacity may vary considerably according to the amount of shale that occurs in various zones in the formation (p. 54, fig. 31).

*Eau Claire formation.*—Only small to moderate amounts of water are available in the upper part of the Eau Claire formation, because of the high dolomite and shale content and the small grain size in this part of the formation (pp. 54-55), but in the lower part of the formation, which is composed dominantly of fine- to coarse-grained sandstone (p. 55), there may be enough water for industrial and municipal supplies. Its greatest potential value is in areas where the formation lies at shallower depths, as in northern LaSalle, southern DeKalb, and eastern Lee counties (pls. 13-29). Some of the deeper wells in north-central Illinois have penetrated the Eau Claire formation and probably obtain a small part of their water from it.

*Galesville formation.*—Large quantities of water are available in the Galesville sandstone, and it is a source of industrial and municipal supplies for some of the larger municipalities in the north half of the region.

The depth to the formation varies considerably over the region (pl. 15) but in general it is shallower in the central and north parts of the region than in the east, south, and west parts.

The Galesville is generally less dolomitic and hence may contain more water in the central part of the region than at Peru and LaSalle and in Grundy and Livingston counties. However, some wells in the Galesville sandstone at Peru are flowing wells.

*Other Cambrian formations.*—Probably relatively little water occurs in the Franconia, Trempealeau, and Jordan formations, although near Sandwich and Millington, where they lie directly under the glacial drift (pl. 13), water for domestic supplies may be available from joints and crevices in them.

ORDOVICIAN SYSTEM

*Prairie du Chien series.*—The Oneota and Shakopee dolomites are not sufficiently porous in themselves to yield water everywhere, but where they are immediately overlain by glacial drift, as in northern LaSalle County (pl. 13), domestic supplies may be available from crevices, joints, and solution cavities in them.

Where the New Richmond sandstone is present in appreciable thickness (pl. 18) it contains moderate amounts of water and furnishes part of the industrial and municipal supplies in some of the larger municipalities of the north half of the region. It is also a source of domestic supplies in northeastern LaSalle County, where it is found at shallow depths (pls. 13, 19, 28). Many wells along Illinois Valley near Marseilles and Ottawa obtain their supply in whole or in part from the New Richmond sandstone, but water from the New Richmond formation in a well in the east part of Starved Rock State Park was unsuitable for use (p. 283). However, over much of the north and northeast parts of the region the New Richmond is thin or absent (pls. 13, 18, 19) and is there of little importance as an aquifer. It occurs at shallower depths in the central part of the region than in the east, south, and west parts (pl. 19).

The variation in dolomite content and grain size of the New Richmond formation (p. 59, fig. 31) make it unpredictable as a source of industrial or municipal supply.

*St. Peter sandstone*[16].—The St. Peter sandstone is the chief source of water for municipal, industrial, and domestic purposes in north-central Illinois. Many domestic wells are drilled into the St. Peter sandstone in the north and north-central parts of the region, where it lies directly under the glacial drift or is capped by a relatively thin layer of Platteville or Pennsylvanian strata or both (pl. 13). Many of the wells in the St. Peter sandstone along Illinois Valley, especially at Ottawa and Marseilles, are flowing wells.

[16]Because drillers generally do not distinguish the Glenwood sandstone from the St. Peter sandstone, it is herein also considered as part of the St. Peter formation.

The thickness of the St. Peter sandstone varies a great deal and is very erratic (pl. 13, 21) on account of erosion both before and since its deposition (p. 61). It is absent in northeastern LaSalle and southern DeKalb counties, but attains a maximum of 578 feet at Morris where it fills a pre-St. Peter river valley (p. 61, pl. 21). Depth to the St. Peter is likewise variable but depends mainly on structure (pl. 22).

The upper part of the St. Peter sandstone itself is coarser grained and more permeable than the lower part and therefore contains more available water. The variation in lithology of the Glenwood formation (p. 62) importantly affects the amount of water it contains. For instance, a well at Gardner (app. C, 42) penetrated 100 feet of the Glenwood formation so dolomitic that it contained no water.

*Galena-Platteville formations.*—The Galena-Platteville formations generally contain little water, but there is water available for domestic supplies from them where they lie directly under glacial drift or are capped by a thin layer of Pennsylvanian or Maquoketa strata (pls. 13, 23, 24, 25), and municipal and industrial supplies have been obtained from them at Depue and Coal City. Except where highly dolomitized (p. 64), these formations are generally not sufficiently porous to serve as aquifers, and the water available in them occurs in joints, crevices, and solution cavities. These formations are absent in most of the north-central and north parts of the region (pl. 13).

*Maquoketa formation.*—The Maquoketa formation is unimportant as an aquifer for industrial and municipal supplies, but in eastern Kendall and Grundy counties, where it lies directly under the glacial drift or a thin layer of Pennsylvanian strata (pls. 13, 25, 26), it is a source of domestic supplies. Most of the water available from this formation occurs in joints and solution cavities in the middle limestone member (p. 66).

## DEVONIAN-SILURIAN SYSTEMS

The Devonian and Silurian systems are unimportant aquifers in north-central Illinois except in northeastern Kendall County, where Silurian dolomite is immediately overlain by glacial drift (pls. 13, 27) and many domestic wells obtain their supply from groundwater that is available in joints and solution cavities in its weathered upper portion.

## MISSISSIPPIAN SYSTEM

The Mississippian system in north-central Illinois consists only of the compact Kinderhook shales (p. 69, fig. 31), and so is of no importance as a groundwater aquifer.

## PENNSYLVANIAN SYSTEM

Pennsylvanian strata occur over the south part of the Ottawa and Marseilles and most of the Streator quadrangles (pl. 11). Although no municipal or industrial supplies are obtained from them, their sandstones furnish domestic supplies in the south half of the Marseilles quadrangle, the extreme south part of the Ottawa quadrangle, and all of the Streator quadrangle, except in Ticona Valley (pl. 4, fig. 88, p. 150). However, because there are generally no sandstones in the lower 75 feet of the Pennsylvanian system, there are no aquifers in the marginal parts of the area underlain by the Pennsylvanian system where it is less than 75 feet thick (p. 84). The best water-bearing horizon in the system is the Vermilionville sandstone (p. 127). The sandstones at the base of the Sparland and Gimlet cyclothems (pp. 136, 139) are also locally good aquifers.

## PLEISTOCENE SYSTEM

Many wells in the quadrangles obtain water from thick sand and gravel beds which occur in the deep preglacial valleys of River Ticona and its tributaries (pls. 4, 5, 6). Grand Ridge obtains its municipal supply from this source. No industrial wells are located in the area underlain by River Ticona gravels, but large quantities of water are probably available from them.

Many domestic wells obtain their supply from the glacial drift, either by shallow dug wells or by wells drilled into local deposits of sand and gravel in the moraine and ground-moraine areas (pls. 1, 2, 3).

Throughout Illinois Valley in the Marseilles and Ottawa quadrangles the bedrock lies at very shallow depths, and consequently there are no thick deposits of water-bearing glacial gravels, such as those both to the east and to the west at Morris and LaSalle.

### SPRINGS

There are three types of springs in the quadrangles: (1) Those that issue from bedrock; (2) those that issue at the contact of bedrock and glacial drift; and (3) those that issue at the contact of gravel with till in the drift.

Of the bedrock springs, some of those that issue from the St. Peter sandstone are mineral springs. Some of these are salty (see below, pl. 5); while others contain considerable hydrogen sulfide gas. Salty springs from the St. Peter sandstone occur at the east end of Starved Rock State Park and east of the south end of the highway bridge at Ottawa. The spring at Sulfur Springs Health Resort south of Wedron contains hydrogen sulfide. There are also small and intermittent springs from Pennsylvanian sandstones, especially at the base of the sandstones where they overlie shales.

The Brookfield Spring three miles southeast of Marseilles issues at the contact of bedrock and glacial drift. There are many others of this type along nearly all the stream valleys which cut into bedrock.

Springs are also very common within glacial drift at the contacts of gravel with glacial till. Most of these are intermittent springs, but many of them serve as sources of water for private use.

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## BRINES

Before 1700, French colonists were making salt[17] from salt marshes in a shallow depression on a terrace slightly above Illinois River just east of Starved Rock State Park. The salty water came from springs issuing from the St. Peter sandstone at the base of the south bluff of Illinois Valley.

Many wells drilled in the south, especially the southwest, part of the Ottawa quadrangle (pl. 5) have penetrated strata containing salty water, and in some of these wells, and also in others not noticeably salty, there is a strong concentration of hydrogen sulphide gas. In two deep wells at Streator and one three miles north of Marseilles the water was also salty (pls. 4, 6).

Most of the salty-water wells in the Ottawa quadrangle penetrate to the base of the Shakopee dolomite or into the New Richmond sandstone, although some are known to be deeper (fig. 31). However, for most of these wells there are few data concerning the variations in the saltiness of the water with depth. A well that many years ago was drilled to a depth of 258 feet (probably ending in the New Richmond sandstone) near the salt springs at the east end of Starved Rock State Park, had salty water throughout but at the bottom it encountered a strong artesian flow, after which the water from the well was less salty than it had been before, so higher strata were thought to be the source of the salt.[18] However, a well drilled in 1933 for the C.C.C. camp in the Park, about two miles west of the above well, when cased to the New Richmond sandstone, gave water that was saltier than when the well was cased only through the upper part of the Shakopee formation. This indicates that the salt is not derived, at least not entirely, from higher strata. As the salty-water wells are near "fresh-water" wells that apparently obtain their water from the same strata, the salty water appears to be localized in the strata. This localization may be due either to isolated bodies of salt water in the formations themselves or to local introduction of salty water from the Mt. Simon sandstone into higher "fresh-water" aquifers through joints that penetrate all the formations.

It may be noted that the salty-water wells are restricted to an area that is affected by the Marseilles anticline (p. 187) east of the crest of the LaSalle anticline. This restriction may be owing to the coincidence of these two structures or to the fact that, of all the structures in the Marseilles-Ottawa-Streator quadrangles, the Marseilles is the only one that suffered movement throughout Cambrian and Or-

[17]Baldwin, E., History of LaSalle county, 1877.

[18]Freeman, H. C., LaSalle county, in Worthen, A. H., Geology and Paleontology: Geological Survey of Illinois, vol. 3, p. 286, 1868.

dovician times (p. 192). There is also a suggestion that most of the salty-water wells may be further restricted to the local synclines crossing the Marseilles anticline (pls. 18, 20), in which case the salty water may be derived from local structural basins which have not been flushed out by "fresh" water. Or the localization of the salty-water wells may be due to the fact that they are located at or near joints that penetrate the various formations and so provide avenues for saline water from the Mt. Simon sandstone to rise and contaminate higher aquifers that normally carry "fresh" water.

The concentration of salt in these waters is much less than in commercial brines used at present in the manufacture of salt. All the salty-water wells and springs probably contain water from various strata, and it is possible that water with a higher concentration of salt might be obtained if the supply be restricted to the salt-bearing strata. However, it is believed that brines having high enough concentrations to be of commercial value are not available in upper strata. Although the upper part of the Mt. Simon formation is commonly an important source of fresh-water for industrial and public water supplies, it is likely that throughout the quadrangles the lower part contains salty water. Some of the brines from deep wells elsewhere in Illinois contain as high a concentration of salt as some brines now being used commercially.[19]

[19]Lamar, J. E., Unexploited or little known industrial minerals of Illinois: in Current developments in rock, rock products, and industrial minerals: Illinois Geol. Survey, Circular No. 23-D, pp. 48-50, 1938.

## SOILS

The soil which mantles almost the entire area is its most valuable mineral resource. Agriculture is the most important industry of the area both from the viewpoint of value of its products and number of people employed. The uplands form about 90 per cent of the area and are covered with fertile prairie soils except for areas near the valleys where the rich but thinner timber soils occur. The flatness of the uplands permits almost complete utilization of the area for agricultural purposes. Some of the valleys have bottom-lands broad enough to be used for field crops, but in a considerable part of the terrace areas in Illinois Valley the soil is thin and the bedrock is so close to the surface that the land is used principally for pasture. Most of the timbered upland areas have been cleared but many of the valleys are partially timbered and are used mostly for pasture. The character of the soils is described in more detail elsewhere (p. 176).

# APPENDIX A—GEOLOGIC SECTIONS

By H. B. Willman

1-34 Pennsylvanian
35-102 Pleistocene

*Geologic section 1.—Outcrop along North Kickapoo Creek south of highway, SW. ¼ SE. ¼ NE. ¼ sec. 21, T. 33 N., R. 5 E. (Manlius Twp.), Marseilles quadrangle.*

| Unit No. | | Thickness Ft. | In. |
|---|---|---|---|
| | Pennsylvanian system | | |
| | Brereton cyclothem | | |
| 41 | Vermilionville sandstone, silty, brown, fine-grained, micaceous; thin-bedded at base, massive at top | 6 | |
| | St. David cyclothem | | |
| 40 | Canton shale, gray, thin-bedded; contains layers of discoid limonite-coated gray ironstone concretions | 5 | |
| 39 | Shale, black, soft, thin-bedded | | 8 |
| " | Shale, black, hard, sheety; *Aviculopecten rectilaterarius* abundant at base | 1 | 2 |
| 38 | Shale, black, soft | | 2 |
| 37 | Limestone, shaly, black; contains white fossils | | 1 |
| 36 | Shale, dark gray, thin-bedded; *Estheria* common | | 7 |
| | Summum cyclothem | | |
| 35 | Covel conglomerate, pyritic; weathers rusty | | 1 |
| 33 | Clay, greenish-gray | 1 | |
| 32 | Limestone, gray, dense, nodular, discontinuous | | 0–2 |
| 29 | Clay, greenish-gray; faintly bedded at base | 2 | |
| 28 | Hanover limestone, gray, nodular; contains small black limestone grains | | 6–8 |
| 27 | Shale, light green and very dark gray interbedded; contains few limestone nodules | 1 | 3 |
| 26 | Shale, black; contains charcoal streaks | | 2 |
| 25 | Clay, gray, noncalcareous; base concealed | | 8 |

*Geologic section[1] 2.—Silver Coal and Clay Co. mine, formerly operated by the Chicago Firebrick Co., 2 miles east of Marseilles, SE. ¼ NW. ¼ sec. 21, T. 33 N., R. 5 E. (Manlius Twp.), Marseilles quadrangle.*

| Unit No. | | Thickness Ft. | In. |
|---|---|---|---|
| | Shaft from surface to top of coal | 90± | |
| | Pennsylvanian system | | |
| | Liverpool cyclothem | | |
| 4 | LaSalle (No. 2) coal | 2 | 6 |
| 3 | "Fireclay," drab, comparatively free from pyrite but colored by carbon | 3½–6 | |
| 2 | Clay, green, rich in pyrite | ½–3 | |
| 1 | "Fireclay;" pyrite in small crystals to bottom of present workings; a maximum of 12 feet of this lower clay has been penetrated; at the shaft the St. Peter sandstone is 8 feet 4 inches below the bottom of the coal | 5 | |
| | Sample No. 129 was taken from the working face, omitting the green clay. | | |

[1] Parmelee, C. W., and Schroyer, C. R., Further investigations of Illinois fire clays: Illinois Geol. Survey Bull. 38, p. 392, 1922.

*Geologic section 3.—Composite section of outcrops along Illinois Waterway canal and Illinois River, SW. ¼ NW. ¼ NE. ¼ sec. 24, T. 33 N., R. 4 E. (Fall River Twp.), Marseilles quadrangle.*

| Unit No. | | Thickness Ft. | In. |
|---|---|---|---|
| | Pennsylvanian system | | |
| | Brereton cyclothem | | |
| 41 | Vermilionville sandstone, brown, very fine-grained, micaceous, 2- to 4-inch beds | 3 | |
| | St. David cyclothem | | |
| 40 | Canton shale, dark gray, thin-bedded; contains layers of fossiliferous discoid ironstone concretions; grades into underlying shale | 3 | |
| 39 | Shale, black, thin-bedded; weathers flaky | 1 | |
| " | Shale, black, hard, sheety; contains many small limestone concretions; *Aviculopecten rectilaterarius* abundant at base | 1 | 6 |
| 38 | Shale, black, soft | | 2 |
| 37 | Limestone, shaly, black; contains white fossils | | 2 |
| 36 | Shale, very dark gray, thin-bedded; contains thin lenses of limestone with cone-in-cone structure generally parallel to beds but partly vein-like; *Estheria* common | | 8 |
| | Summum cyclothem | | |
| 35 | Covel conglomerate, fine-grained, pyritic, 0-1 inch thick; sharply tapering lenses of gray semilithographic argillaceous limestone up to 4 inches thick are locally present on top of conglomerate and 0-3 inches of limestone with cone-in-cone structure occurs along base | | 0–5 |
| 34 | Shale, gray, very thin-bedded; contains few limestone nodules | 1 | 6 |
| 33 | Clay, dark greenish-gray | | 4 |

| Unit No. | | Thickness Ft. | In. |
|---|---|---|---|
| 32 | Limestone, gray, dense, semilithographic; has conchoidal fracture; usually a persistent bed but locally is nodular, 1 to 2 inches of limestone with cone-in-cone structure occurs irregularly along top and bottom | | 4-8 |
| 31 | Clay, dark greenish-gray | | 3 |
| " | Limestone, gray; occurs in nodules very closely spaced in clay forming a conglomerate-like mass | | 1–3 |
| " | Shale, dark gray, thin-bedded | | 4 |
| 30 | Limestone conglomerate; more conspicuous than Covel conglomerate but more erratic in occurrence | | 0–3 |
| 29 | Clay, greenish-gray | 2–3 | |
| 28 | Hanover limestone, light gray; upper 6 inches brecciated and weathers gray, lower part very fine-grained and weathers rusty, irregular clayey partings; locally is a single ledge; lower surface knobby; sparingly fossiliferous | 1⅔-2½ | |
| 27 | Shale, soft, thin-bedded; green and black interbedded | 1-1½ | |
| 26 | Shale, black; contains thin streaks of bright coal | | 1–2 |
| 25 | Clay, gray, upper 2 feet noncalcareous | 3 | |
| 22-24 | Clay, dark greenish-gray with purple streaks | 1 | 6 |
| 20 | Clay, sandy, light gray, limonitic | | 6 |
| 18 | Clay, very sandy, greenish-gray | 1 | |
| 17 | Pleasantview sandstone | | |
| | Siltstone, sandy, calcareous, hard; forms single ledge | 2 | |
| | Siltstone and clayey and silty shale, light greenish-gray, ¼-1 inch beds, soft | 3–4 | |
| | Sandstone, light gray, very fine-grained, micaceous, ripple-marked, beds 1 to 6 inches; weathers gray with limonitic streaks, base concealed | 6 | |

*Geologic section 4.—Composite section of outcrops along stream for 100 yards in SE. ¼ SW. ¼ NE. ¼ sec. 21, T. 34 N., R. 4 E. (Rutland Twp.), Ottawa quadrangle.*

| Unit No. | | Thickness Ft. | In. |
|---|---|---|---|
| | Pennsylvanian system | | |
| | St. David cyclothem | | |
| 36 | Shale, very dark gray, thin-bedded; contains locally about middle a thin band of limestone with cone-in-cone structure | | 11 |
| | Summum cyclothem | | |
| 35 | Covel conglomerate, fine-grained, pyritic; associated with lenses of gray dense limestone; conglomerate usually at base but in places is split into several bands, locally 6, through the lenses | | 0–6 |
| 34 | Shale, black, soft | | 0–½ |
| " | Shale, dark gray, soft, thin-bedded | 1 | 6 |
| 33 | Clay, greenish-gray | | 0–6 |
| 32 | Limestone, argillaceous, greenish-gray, nodular; has algal structure and weathered surface is intricately etched | | 0–6 |
| 29 | Clay, dark greenish-gray, calcareous | 2 | 6 |
| 28 | Hanover limestone, light gray, medium crystalline, very fossiliferous | 1–2 | |
| 27 | Shale; interbedded grayish-green and black; contains large nearly spherical dark gray limestone concretions and lenses of dark gray limestone with small grains of black limestone | 3 | |
| 26 | Shale, coaly, black | | 1 |
| 25 | Clay, gray | 5 | |
| 22-24 | Clay, greenish-gray | 2 | |
| 22 | Clay, limonitic | | 8 |
| 20 | Clay, very light gray, plastic | | 6 |
| 19 | Clay, black, soft | | 0–½ |
| 18 | Clay, greenish-gray; grades into underlying clay | 2 | |
| 17 | Pleasantview sandstone | | |
| | Clay, very sandy, greenish-gray, micaceous; locally is calcareous, hard, and ledge-forming | 2 | 6 |
| | Shale, light grayish-green, thin-bedded; partly mottled red | 2½–3 | |
| | Siltstone, sandy, gray, calcareous; weathered surface has large rusty splotches; upper 6 inches to 1 foot very hard; lower part softer; base concealed | 3 | |

*Geologic section 5.—Composite section along ravine southeast from road, NE. ¼ SE. ¼ NE. ¼ sec. 31, T. 34 N., R. 4 E. (Dayton Twp.), Ottawa quadrangle.*

| Unit No. | | Thickness Ft. | In. |
|---|---|---|---|
| | Pennsylvanian system | | |
| | St. David cyclothem | | |
| 39 | Shale, black, hard, sheety; *Aviculopecten rectilaterarius* abundant at base | 1 | |
| 38 | Shale, black, soft | | 2 |
| 37 | Limestone, shaly, black; contains white fossils | | 1 |
| 36 | Shale, very dark gray, soft, thin-bedded; *Estheria* common | | 4 |
| | Summum cyclothem | | |
| 35 | Covel conglomerate | | |
| | Limestone, light gray, semilithographic, dense, lenses of limestone conglomerate ½ inch thick occur locally in middle of limestone bed; cone-in-cone structure, 1 to | | |

| Unit No. | | Thickness Ft. | In. |
|---|---|---|---|
| | 2 inches thick, along top and bottom; where bed is less than 2 inches thick it consists entirely of cone-in-cone structure | 0–1 | |
| 34 | Shale, gray, soft, calcareous | 1 | 8 |
| 32 | Limestone, greenish-gray, nodular | | 0–3 |
| 29 | Clay, light greenish-gray, calcareous | 2 | 6 |
| 28 | Hanover limestone, greenish-gray, weathering rusty, nodular, fossiliferous; irregular clay partings divide limestone into 2 or 3 beds; cone-in-cone structure locally along top | 1–2 | |
| 27 | Shale, interbedded green and black, thin-bedded; contains large gray limestone concretions and lenses of dark gray limestone speckled with small grains of black limestone | 1 | |
| 26 | Shale, coaly, black | | 2 |
| 25 | Clay, gray; upper 2 feet noncalcareous | 6 | |
| 17 | Pleasantview sandstone | | |
| | Siltstone, light gray, calcareous, hard | 2 | |
| | Siltstone, light gray, soft, grades into underlying shale | 3 | |
| | Liverpool cyclothem | | |
| 5 | Francis Creek shale, silty, gray; base concealed | 10 | |

*Geologic section[1] 6.—Pit formerly operated by the National Fireproofing Co., east of Ottawa, SW. ¼ sec. 7, T. 33 N., R. 4 E. (Rutland Twp.), Ottawa quadrangle.*

| Unit No. | | Ft. | In. |
|---|---|---|---|
| | Pennsylvanian system | | |
| | Liverpool cyclothem | | |
| 5 | Francis Creek shale | 16 | |
| 4 | LaSalle (No. 2) coal | 2 | 2 |
| 3 | "Fireclay," dark | 1 | |
| " | "Fireclay," light gray, (Sample 91); lenses of large rounded pisolitic boulders which contain large amounts of pyrite | 8 | |
| 2 | Clay, green, in lenses, local | | 2 |
| | Sandstone, hard, brown | 1–4 | |
| 1 | Clay, very light gray (Sample 92) | 5–9 | |
| " | Clay, sandy; overlies St. Peter sandstone | 1 | |

[1]Parmelee, C. W., and Schroyer, C. R., Further investigations of Illinois fire clays, Illinois Geol. Survey, Bull. 38, p. 390, 1922.

*Geologic section 7.—Cut-bank north side Covel Creek, NW. ¼ SW. ¼ NE. ¼ sec. 26, T. 33 N., R. 3 E. (South Ottawa Twp.), Ottawa quadrangle.*

| Unit No. | | Thickness Ft. | In. |
|---|---|---|---|
| | Pennsylvanian system | | |
| | St. David cyclothem | | |
| 40 | Canton shale | | |
| | Shale, gray, medium-bedded | 13 | |
| | Coal, cannel | | 3 |
| | Shale, gray, medium-bedded | 7 | |
| | Shale, dark gray, thin-bedded; contains layers of discoid fossiliferous limonite-coated dark gray ironstone concretions | 6 | |
| 39 | Shale, black, hard, sheety; *Aviculopecten rectilaterarius* abundant at base | 1 | 10 |
| 38 | Shale, black, soft | | 2 |
| 37 | Limestone, shaly, black, hard; contains white fossils | | 2 |
| 36 | Shale, black, soft; contains a 1-inch band of limestone with cone-in-cone structure which locally cuts across bedding like vein | | 6–8 |
| | Summum cyclothem | | |
| 35 | Covel conglomerate; only locally present | | 0–2 |
| 34 | Shale, gray, hard, thin-bedded | 1 | 8 |
| 32 | Limestone, gray, fine-grained; contains small black pebbles in upper 1 inch giving conglomeratic appearance; thin cone-in-cone locally at top | ½–1 | |
| 29 | Clay, sandy, gray | 6 | |
| 28 | Hanover limestone, gray; contains green clay and black limestone in small lenses | 1 | 6 |
| 27 | Shale; interbedded greenish-gray and black | | 8 |
| " | Limestone, gray; contains many black specks | | 2–4 |
| " | Shale, black, soft | | 2 |
| " | Shale, mottled greenish-gray and black, thin-bedded | 1 | 2 |
| " | Shale, black, soft | | 4 |
| 26 | Summum (No. 4) coal | | 2 |
| 25 | Clay, dark to medium gray; upper 2½ feet noncalcareous | 4 | |
| 20 | Clay, very light gray, plastic; stained with limonite | | 6 |
| 18 | Clay, dark gray | | 10 |
| " | Limestone, gray, nodular, rough-surfaced | | 6 |
| " | Clay, silty, gray | 1 | |
| 17 | Pleasantview sandstone | | |
| | Siltstone, gray, beds 2 to 6 inches thick, ripple-marked; contains beds of very fine-grained sandstone | 8 | |
| | Liverpool cyclothem | | |
| 5 | Francis Creek shale, sandy, gray; contains large sandy gray limestone concretions; base concealed | 15 | |

*Geologic section 8.—Composite section along tributary to Covel Creek below road, along west line of NW. ¼ SW. ¼ sec. 27, T. 33 N., R. 3 E. (South Ottawa Twp.), Ottawa quadrangle.*

| Unit No. | | Ft. | In. |
|---|---|---|---|
| | Pennsylvanian system | | |
| | St. David cyclothem | | |
| 40 | Canton shale, gray; contains layers of discoid limonite-stained fossiliferous ironstone concretions | 20 | |

| Unit No. | | Thickness Ft. | In. |
|---|---|---|---|
| 39 | Shale, black, soft, thin-bedded, flaky | | 6 |
| " | Shale, black, hard, sheety; *Aviculopecten rectilaterarius* abundant at base | 1 | 8 |
| 38 | Shale, black, soft | | 2 |
| 37 | Limestone, shaly, black; contains white fossils | | 0–1 |
| 36 | Shale, dark gray, calcareous | | 7 |
| | Summum cyclothem | | |
| 35 | Covel conglomerate | | 1–3 |
| 29 | Clay, greenish-gray | 3 | 6 |
| 28 | Hanover limestone, gray, semi-lithographic, fossiliferous | 2½-3 | |
| 27 | Shale, light greenish-gray, very thin-bedded; contains lenses of limestone | | 6 |
| " | Shale, gray, very thin-bedded | | 6 |
| " | Limestone, gray, very lenticular, wavy bedding planes; contains many small grains of black limestone | | 0–4 |
| " | Shale, dark gray, very thin-bedded; contains thin limestone beds | | 8 |
| " | Limestone, as above | | 0–1 |
| " | Shale; interbedded dark gray and green | | 6 |
| " | Limestone, as above | | 0–8 |
| " | Shale, dark greenish-gray, very thin-bedded | 1 | |
| " | Shale; interbedded and mottled dark gray, black and green | 1 | |
| 26 | Shale, black, soft | | 2 |
| 25 | Clay, gray | 3 | |
| 22-24? | Clay, light gray | | 6 |
| 21? | Clay, black | | ¼ |
| 20 | Clay, light gray; contains many limonitic streaks, especially in lower part | 1 | 6 |
| 18? | Clay, gray | 1 | |
| 17 | Pleasantview sandstone | | |
| | Siltstone, calcareous, light gray, hard; varies from single massive bed to many irregular 1- to 4-inch beds | 1 | 6 |
| | Liverpool cyclothem | | |
| 5 | Francis Creek shale, very sandy, light gray, medium-bedded; contains sandy limestone nodules with limonitic streaks; base concealed | 10 | |

*Geologic section 9.—Composite section along Little Horseshoe Canyon, NW. ¼ SW. ¼ and SW. ¼ NW. ¼ sec. 30, T. 33 N., R. 3 E. (South Ottawa Twp.), Ottawa quadrangle.*

| Unit No. | | Thickness Ft. | In. |
|---|---|---|---|
| | Pennsylvanian system | | |
| | Brereton cyclothem | | |
| 41 | Vermilionville sandstone, silty, brownish-gray, micaceous, 2-6 inch beds | 5 | |
| | St. David cyclothem | | |
| 40 | Canton shale, gray, soft, medium-bedded | 8 | |
| 39 | Shale, black, hard, sheety; *Aviculopecten rectilaterarius* abundant at base | 1 | 6 |
| 38 | Shale, dark gray, soft | | 1 |
| 37 | Limestone, shaly, black; contains white fossils | | 1–2 |
| 36 | Shale, dark gray, *Estheria* | | 3 |
| " | Limestone, gray, dense | | 0–2 |
| " | Shale, dark gray | | 2 |
| | Summum cyclothem | | |
| 35 | Covel conglomerate, pyritic; pebbles and cobbles to 5 inches in diameter; locally in three beds separated by fine-grained gray limestone; 0-2 inches limestone with cone-in-cone structure along top | | 1–5 |
| 34 | Shale, light gray, thin-bedded | ½-1 | |
| 27 | Limestone, sandy, brownish-gray; contains plant fragments | | 0–3 |
| " | Shale, dark gray, thin-bedded | | 3 |
| " | Siltstone, gray, calcareous, hard, laminated | | ½ |
| " | Shale, dark gray, thin-bedded | | 3 |
| " | Limestone, sandy, gray; contains many rod-like markings | | 1–2 |
| " | Shale, interbedded green and black, thin-bedded; contains large oval limestone concretions with plant impressions | 1 | 6 |
| " | Shale, black, hard, sheety | 1 | 2 |
| " | Limestone, gray, fine-grained; contains many plant impressions | ½–1 | |
| 25 | Clay, gray | 2 | |
| 24 | Clay, light greenish-gray; contains limestone nodules | 3 | 6 |
| 23 | Limestone, light gray; weathers white and rough surfaced | | 1–6 |
| 22 | Clay, mixed dark gray and greenish-gray; contains limestone nodules | | 6 |
| 18–21 | Clay, light greenish-gray with dark gray streaks, contains limestone nodules up to 6 inches thick | 3 | |
| 18 | Clay, sandy, light greenish-gray | 1 | 6 |
| 17 | Pleasantview sandstone | | |
| | Siltstone, sandy, light gray, calcareous | 2 | |
| | Lowell cyclothem | | |
| 16 | Shale, sandy, light greenish-gray; contains many rough-surfaced rusty-weathering limestone nodules | 1 | 4 |
| " | Shale, medium-bedded; as above but has few nodules | 2 | |
| " | Shale, bluish-gray, thin-bedded; contains nearly spherical rusty-weathering gray limestone concretions | | 8 |
| 14 | Shale, mottled green and red, thin-bedded | 1 | 3 |
| 13 | Limestone, brownish-gray, rusty-weathering; grades into layer of nodules | | 3–6 |
| 12 | Shale, mostly light greenish-gray and bluish-gray but locally | | |

| Unit No. | | Thickness Ft. | Thickness In. |
|---|---|---|---|
| | upper 1 foot is mottled red, thin-bedded | 1 | 8 |
| 11 | Shale, black; contains plant impressions | | 2 |
| 9 | Shale, very sandy, dark gray, thin-bedded; contains plant fragments and thin beds of micaceous silty sandstone | 1 | 2 |
| | Liverpool cyclothem | | |
| 5 | Francis Creek shale, light bluish-gray, thin-bedded; mottled red in interval from 3 to 10 feet below top; contains irregular limestone masses up to 3 feet thick; base concealed | 20 | |

*Geologic section 10.—Streator Brick Co. pit, southwest of Starved Rock, SW. ¼ NE. ¼ sec. 21, T. 33 N., R. 2 E. (Deer Park Twp.), Ottawa quadrangle.*

| Unit No. | | Thickness Ft. | Thickness In. |
|---|---|---|---|
| | Pennsylvanian system | | |
| | Liverpool cyclothem | | |
| 5 | Francis Creek shale, gray | 5 | |
| 4 | LaSalle (No. 2) coal | 2 | 3 |
| 3 | Clay, dark gray; faint horizontal laminations | | 3 |
| " | Clay, gray, breaks into small angular fragments | 1 | |
| " | Clay, gray; limonite stains along fractures; breaks into much larger fragments than clay above; sharp contact below with | 1 | 10 |
| 2 | Clay, light grayish-green; faint bedding planes | | 9 |
| 1 | Clay yellowish-gray, very plastic | | 3 |
| " | Clay, gray; light yellow stains on fracture surfaces | 3 | |
| " | Clay, gray, very plastic; overlies Platteville limestone which occurs in irregular masses with solution-etched surfaces | 3 | |

*Geologic section 11.—Composite section along Illinois Canyon, NE. ¼ sec. 36, and SE. ¼ sec. 25, T. 33 N., R. 2 E. (Deer Park Twp.), Ottawa quadrangle.*

| Unit No. | | Thickness Ft. | Thickness In. |
|---|---|---|---|
| | Pennsylvanian system | | |
| | St. David cyclothem | | |
| 39 | Shale, black, hard, sheety; *Aviculopecten rectilaterarius* abundant at base | 1 | |
| 38 | Shale, black, soft, thin-bedded | | 1 |
| 37 | Limestone, shaly, black; contains white fossils | | 0–2 |
| 36 | Shale, dark gray, soft, thin-bedded; *Estheria* common | | 4 |
| | Summum cyclothem | | |
| 35 | Covel conglomerate, pyritic, fossiliferous | | ½ |
| 34 | Shale, black, soft, thin-bedded | | 1 |
| 30 | Limestone conglomerate; 0–2 inches limestone with cone-in-cone structure on top | | 0–3 |
| 28 | Hanover limestone, gray, dense, brecciated, fossiliferous | 0–1½ | |
| 27 | Shale, gray, thin-bedded | 1 | |
| " | Shale, black, hard, blocky, interbedded with dark gray dense laminated limestone; contains large oval limestone concretions | 3 | |
| 25 | Clay, gray, calcareous except upper 6 inches | 7 | |
| 24 | Clay, light gray | | 5 |
| " | Clay, very light gray | | 3 |
| " | Clay, gray | | 8 |
| " | Clay, black, soft | | ½ |
| " | Clay, dark greenish-gray | | 3 |
| 23 | Limestone, gray, fine-grained | | 0–3 |
| 22 | Clay; mixed dark gray and greenish-gray with black streaks | 1 | |
| " | Clay, gray, calcareous, hard | | 8 |
| " | Limestone, gray, fine-grained, lenticular | | 0–3 |
| " | Clay, dark brownish-gray | | 2 |
| 21 | Clay, black | | ¼ |
| 20 | Clay, very light gray or white; contains rusty streaks | | 5 |
| 19 | Shale, black, coaly; contains ¼ inch light gray clay parting | | 2 |
| 18 | Clay; mixed dark gray, green, and purplish-gray | 1 | |
| 17 | Pleasantview sandstone | | |
| | Siltstone, clayey, light greenish-gray, soft, faintly bedded | 0–1 | |
| | Siltstone, sandy, light greenish-gray, calcareous, hard; large rusty splotches on weathered surface | 1 | 6 |
| | Lowell cyclothem | | |
| 16 | Shale, sandy, very light greenish-gray 1-3 inch beds | 3 | |
| " | Shale, sandy, light gray, thin-bedded | | 8 |
| 14 | Shale, mottled red and green, mostly largely green; thin-bedded; contains lenticular limestone bands | 2 | 6 |
| " | Limestone, light gray, nodular; weathers rusty | | 0–6 |
| " | Shale, light greenish-gray; thin-bedded | | 6 |
| 12 | Shale, red partly mottled with green | | 8 |
| " | Limestone, light gray, nodular; weathers rusty | | 0–5 |
| " | Shale, greenish-gray mottled with red; contains rough-surfaced limestone nodules | 1 | |
| 11 | Shale, black, coaly, thin-bedded | | ½ |
| 9 | Shale, sandy, gray, thin-bedded | | 10 |
| " | Shale, very light gray, very sandy, medium-bedded | | 3 |
| | Liverpool cyclothem | | |
| 8 | Shale, dark gray, thin-bedded | | 3 |
| " | Limestone, gray, weathers rusty | | 1 |
| " | Shale, sandy, very dark gray, thin-bedded | | 6–8 |
| " | Shale, dark gray, gritty, thin-bedded | 1 | |
| " | Limestone, gray, dense, weathers rusty | | 0–4 |
| " | Shale, very sandy, dark gray | | 10 |

| Unit No. | | Thickness Ft. | In. |
|---|---|---|---|
| 7 | Limestone, dark gray, semi-lithographic, septarian, fossiliferous | 0–2 | |
| 5 | Francis Creek shale, gray, thin-bedded; contains a few discontinuous red bands in upper 5 feet | 25–35 | |
| 4 | LaSalle (No. 2) coal; base concealed | 1 | |

*Geologic section 12.—Composite section along tributary to Vermilion River SW. ¼ sec. 10, T. 32 N., R. 2 E. (Deer Park Twp.), Ottawa quadrangle.*

| Unit No. | | Thickness Ft. | In. |
|---|---|---|---|
| | Pennsylvanian system | | |
| | St. David cyclothem | | |
| 40 | Canton shale, dark gray, soft; contains discoid fossiliferous gray rusty-weathering ironstone concretions | 3 | |
| 39 | Shale, black, hard, sheety; contains many small limestone concretions; *Aviculopecten rectilaterarius* abundant in lower 3 inches | 1 | 6 |
| 38 | Shale, black, soft | | 3 |
| 37 | Limestone, shaly, black; contains white fossils, mostly *Marginifera* | | 0–1 |
| 36 | Shale, dark gray, soft, very thin-bedded; *Estheria* common | | 3 |
| | Summum cyclothem | | |
| 35 | Covel conglomerate; generally absent in upper part of ravine | | 0–2 |
| 29 | Clay, greenish-gray, soft; faintly bedded at base; contains many limestone nodules | 3 | |
| 28 | Hanover limestone, greenish-gray, nodular, single bed; thin layer of limestone with cone-in-cone structure locally along top; *Marginifera* abundant | ⅔–2½ | |
| 27 | Shale, interbedded green and dark gray, soft, thin-bedded | | 8 |
| " | Shale, siliceous, black, hard, thick-bedded; contains bands and lenses of dark gray and black limestone; large oval gray ironstone concretions | 4 | 8 |
| 25 | Clay, light gray, calcareous except upper 1 foot 6 inches | 6 | |
| 23 | Limestone, gray, weathered surface whitish and deeply etched | ½–1 | |
| 22 | Clay, light gray, calcareous | | 6 |
| 21 | Clay, black, soft | | ¼ |
| 20 | Clay, very light gray to white; contains limonitic streaks | | 7 |
| 18 | Clay, mixed greenish-gray and purplish-gray | 1 | 2 |
| 17 | Pleasantview sandstone | | |
| | Siltstone, sandy, calcareous, light gray, micaceous, 1- to 6-inch beds; 6 inches at top and 1 foot at base are clayey | 4 | |
| | Lowell cyclothem | | |
| 16 | Shale, silty, light gray, very thin-bedded | 2 | 4 |
| 15 | Limestone, silty, light brownish-gray, weathers rusty | | 2–4 |
| 14 | Shale, light gray, gritty, thin-bedded | 1 | 6 |
| " | Shale, mottled red and light greenish-gray, thin-bedded | 2 | |
| 13 | Limestone, gray, dense; weathers reddish-brown; fossiliferous with *Marginifera* abundant | | 2–8 |
| 12 | Shale, light greenish-gray, thin-bedded; fossils abundant including *Mesolobus mesolobus*, *Ambocoelia planoconvexa*, horn corals, etc. | | 0–2 |
| " | Shale, mottled red and green, mostly red; contains small limestone concretions | 3 | 6 |
| " | Shale, greenish-gray, soft, thin-bedded; contains small limestone concretions | 2 | |
| 11 | Shale, black; contains coaly streaks | | 2–4 |
| 9 | Siltstone, sandy, dark gray, calcareous; contains plant impressions | | 1–6 |
| | Liverpool cyclothem | | |
| 8 | Shale, sandy, gray to dark gray, micaceous, medium-bedded; contains oval limestone concretions and a 4-inch to 1-foot lens of dark gray septarian limestone at base. | 3–5 | |
| 7 | Limestone, dark gray, dense, semi-lithographic; in large septarian concretions, some 2 feet by 3 feet in cross-section; fossils rare | 0–2 | |
| 6 | Shale, black, hard, sheety; contains lenses of gray dense limestone 6 inches thick in lower 1 foot | 3 | |
| 5 | Francis Creek shale, light gray, thin-bedded; base concealed | 6 | |

*Geologic section 13.—Composite section along ravine 2 miles north of Wilsman, W. ½ NW. ¼ sec. 31, T. 32 N., R. 3 E. (Vermilion Twp.), Streator quadrangle.*

| Unit No. | | Thickness Ft. | In. |
|---|---|---|---|
| | Pennsylvanian system | | |
| | St. David cyclothem | | |
| 40 | Canton shale, brownish-gray; contains limonite-coated ironstone concretions | 3 | |
| 39 | Shale, black, hard, sheety; *Aviculopecten rectilaterarius* abundant at base | | 9 |
| 38 | Shale, black, soft | | 3 |
| 37 | Shale, black, calcareous, soft; contains white fossils | | 1 |
| 36 | Shale, black, soft | | 3 |
| | Summum cyclothem | | |
| 35 | Covel conglomerate | | 1 |
| 29 | Clay, gray | 2 | |
| 28 | Hanover limestone, gray, dense, knobby surface, fossiliferous; weathers whitish | 1 | 3 |

| Unit No. | | Thickness Ft. | In. |
|---|---|---|---|
| 27 | Shale, gray | ¾–1 | |
| " | Limestone, black, dense, blocky, interbedded with black shale | 2 | |
| " | Shale, black, hard, laminated | 3 | |
| 25 | Clay, gray | 2 | |
| 17 | Pleasantview sandstone | | |
| | Siltstone, argillaceous, sandy, gray, mostly soft; ¼–4-inch beds; very shaly at base; grades into overlying and underlying beds | 3 | |
| | Lowell cyclothem | | |
| 16 | Shale, very silty and sandy, light greenish-gray, thin-bedded; in places very limonitic | 2 | 6 |
| 15 | Limestone, silty, light greenish-gray; fossils rare | | 4–8 |
| 14 | Shale, gray partly mottled black, thin-bedded, weathers flaky | 3 | |
| 13 | Limestone, gray, fine-grained, lenticular | | 2–4 |
| 12 | Shale, as above | 2 | 6 |
| 11 | Shale, black and dark gray, carbonaceous, soft | | ¼ |
| 9 | Siltstone, dark gray, slightly calcareous, hard; contains black carbonaceous plant fragments | | 2–4 |
| | Liverpool cyclothem | | |
| 5 | Francis Creek shale | | |
| | Shale, sandy, gray, medium-bedded; contains sandy limestone concretions with limonitic streaks; contains several discontinuous beds of siltstone | 15 | |
| " | Shale, sandy, gray; contains several bands of 1-inch limestone concretions coated with limonite | 5 | |
| " | Shale, sandy, gray; contains thin beds of siltstone; base concealed | 5 | |

*Geologic section 14.—Composite section along ravine and roadside ditch north side of road, east side Vermilion Valley at Sandy Ford, SW. ¼ SE. ¼ sec. 32, T. 32 N., R. 3 E. (Farm Ridge Twp.), Streator quadrangle.*

| Unit No. | | Thickness Ft. | In. |
|---|---|---|---|
| | Pennsylvanian system | | |
| | Brereton cyclothem | | |
| 41 | Vermilionville sandstone | | |
| | Shale, dark gray to greenish-gray | 6 | |
| | Sandstone, gray to nearly white | 20 | |
| | Sandstone, brown, hard, blocky | | 3 |
| | Sandstone, light gray | 2 | |
| | Sandstone, shaly, micaceous; contains carbonaceous partings | | 3 |
| | Sandstone, light gray, limonite-stained, faintly laminated | | 8 |
| | Sandstone, shaly, gray, micaceous; contains carbonaceous patches along bedding planes | | 4 |
| | Sandstone, light gray, slightly calcareous; many limonitic concretions give conglomeratic appearance | | 2–3 |
| | Sandstone, brown, hard, ¼-inch beds | | 2 |
| | St. David cyclothem | | |
| 40 | Canton shale | | |
| | Shale, light to dark gray | 1 | |
| | Coal, cannel, black, hard, dense, blocky, limonite-stained | | 3 |
| | Shale, light gray, soft | | 1–4 |
| | Shale, gray; contains limonite-coated ironstone concretions mostly in bands; concretions near base are fossiliferous | 10 | |
| 39 | Shale, black, hard, flaky | | 7 |
| " | Shale, black, hard, sheety; *Aviculopecten rectilaterarius* abundant at base | 1 | 8 |
| 38 | Shale, black, soft | | 3 |
| 37 | Limestone, shaly, black; contains white fossils | | 2 |
| 36 | Shale, black, hard | | 2 |
| | Summum cyclothem | | |
| 35 | Covel conglomerate; contains some cobbles 3-4 inches in diameter | | 1–5 |
| 28 | Hanover limestone, bluish-gray, dense, fossiliferous | 1 | 2 |
| 27 | Shale, interbedded light and dark, hard, siliceous, blocky | 3 | |
| " | Shale, greenish-gray | | 3 |
| " | Shale, black, soft | | 3 |
| " | Shale, black, hard, sheety; contains large spherical limestone concretions | 3 | |
| 26 | Summum (No. 4) coal | | 3–4 |
| 25 | Clay, light gray to gray, upper 1 foot 6 inches noncalcareous; contains plant impressions | 2 | 8 |
| 17 | Pleasantview sandstone | | |
| | Shale, silty, light greenish-gray | 1 | |
| | Siltstone, light gray, calcareous, hard | | 9 |
| | Lowell cyclothem | | |
| 16 | Shale, silty, light greenish-gray; contains many limestone nodules in lower part | 3 | |
| 15 | Limestone, silty, gray, nodular, weathers tan | | 0–8 |
| 14 | Shale, silty, light greenish-gray; contains many small limestone nodules | ⅔–1 | |
| 13 | Limestone, silty, light gray | | 2–6 |
| 12 | Shale, light gray; base concealed | 2 | |

*Geologic section 15.—Outcrop along small ravine south side Vermilion River, one-fourth mile west of Klein Bridge, NE. ¼ SE. ¼ SW. ¼ sec. 9, T. 31 N., R. 3 E. (Eagle Twp.), Streator quadrangle.*

| Unit No. | | Thickness Ft. | In. |
|---|---|---|---|
| | Pennsylvanian system | | |
| | Brereton cyclothem | | |
| 51 | Herrin (No. 6) coal; contains many slate, clay, and pyrite partings; top eroded . . . | 4 | |
| " | Shale, black, sheety . . . . . | | 9 |
| " | Shale, interbedded dark gray, light gray and black, thin-bedded, partly clayey . . | | 6 |
| " | Coal . . . . . . . . . . . . . | 1 | |
| 51? | Shale, dark gray, micaceous, hard, thin-bedded, partly sheety; contains many plant impressions . . . . . . . | | 4 |
| 50 | Clay, very sandy, light gray, micaceous; contains carbonaceous plant fragments | 3 | |
| 41 | Vermilionville sandstone | | |
| | Sandstone, silty, gray, micaceous, thin-bedded . . . . | 4 | |
| | Covered . . . . . . . . . . | 3 | |
| | Sandstone, gray, micaceous; beds variable from thin to 2 feet thick; base concealed | 10 | |

*Geologic section 16.—Outcrop along small gully south side Vermilion River, 100 yards west of Klein Bridge, SW. ¼ SE. ¼ SE. ¼ sec. 9, T. 31 N., R. 3 E. (Eagle Twp.), Streator quadrangle.*

| Unit No. | | Thickness Ft. | In. |
|---|---|---|---|
| | Pennsylvanian system | | |
| | Sparland cyclothem | | |
| 58 | Copperas Creek sandstone, silty, brownish-gray, micaceous, thin-bedded; uniform parallel beds . . . . . . . . | 3 | |
| | Brereton cyclothem | | |
| 57 | Shale, light greenish-gray, soft, 2-3 inch beds; fossiliferous with *Chonetids* and *Productids* abundant . . . . . . | 13 | |
| 56 | Limestone, argillaceous, light gray, dense, conchoidal fracture, 2-4 inch beds, fossiliferous; grades laterally and vertically to calcareous shale . . . . . . . . . . . | 2 | |
| 55 | Shale, light gray, calcareous, soft, thin-bedded . . . . | 1 | |
| 54 | Shale, black, soft, thin-bedded . | 4 | |
| " | Shale, black, moderately hard, blocky fracture, ¼-2 inch beds; fossiliferous; contains black limestone nodules 6 inches thick in two bands in lower part . . . . . . . | 10 | |
| 51 | Herrin (No. 6) coal (in old mine); base concealed . . | 3 | |

*Geologic section 17.—Outcrop in road-cut 100 yards southeast of Klein Bridge, SE. ¼ SE. ¼ SE. ¼ sec. 9, T. 31 N., R. 3 E. (Eagle Twp.), Streator quadrangle.*

| Unit No. | | Thickness Ft. | In. |
|---|---|---|---|
| | Pennsylvanian system | | |
| | Brereton cyclothem | | |
| 55-57 | Shale, light yellowish-gray, soft, medium-bedded; 1-3 inch limestone bands cut through shale in all directions; contains beds of argillaceous ochre 8 to 10 inches thick near base; fossiliferous, *Chonetids* abundant . | 7–12 | |
| 54 | Shale, black, mostly soft, medium to thin-bedded; fossiliferous; upper 5 feet grades laterally into shale like above; contains several bands of brown sandy micaceous shale in upper part and large dark gray limestone concretions in band 1 foot above base and a few at other horizons . . | 8 | |
| " | Shale, black, blocky, thick-bedded; soft to hard, laminated and sheety; fossils common, chiefly pelecypods | 2 | |
| 51 | Herrin (No. 6) coal | | |
| | Coal, few thin discontinuous clay partings . . . . . . | | 7 |
| | Clay, gray, faintly bedded . | | 0–1 |
| | Coal . . . . . . . . . . . . | | 2 |
| | Clay, gray, faintly bedded; contains thin lenses of coal | | 0–3 |
| | Coal, several very thin clay partings . . . . . . . . | | 6 |
| | Clay, gray, faintly bedded . | | 0–3 |
| | Coal . . . . . . . . . . . . | | 9 |
| | Clay, gray, faintly bedded . | | 0–½ |
| | Coal . . . . . . . . . . . . | | 5 |
| | Clay, gray, faintly bedded . | | 0–½ |
| | Coal, several very thin and lenticular clay partings . . | 1 | 6 |
| 48 | Shale, carbonaceous, interbedded black and gray, laminated, partly sheety; contains thin lenticular beds of coal; plant impressions locally abundant; base concealed . . . . . . . . . | 4 | |

*Geologic section 18.—Exposures at mouth of ravine, in strip mine, and in slumped mine entries northeast of Klein Bridge, NE. ¼ SE. ¼ SE. ¼ sec. 9, T. 31 N., R. 3 E. (Bruce Twp.), Streator quadrangle.*

| Unit No. | | Thickness Ft. | In. |
|---|---|---|---|
| | Pennsylvanian system | | |
| | Sparland cyclothem | | |
| 58 | Copperas Creek sandstone, silty, light gray, micaceous, calcareous, thin-bedded; sharp contact with beds below . | 10 | |
| | Brereton cyclothem | | |
| 57 | Shale, light brownish-gray, beds 1-3 inches thick; very fossiliferous in streaks, gradational downward . . . . . | 4–5 | |
| 56 | Limestone, very argillaceous, mottled light and medium gray, fossiliferous; grades laterally to shale and argillaceous ochre in shale . . . | ½-4 | |
| 54 | Shale, black, hard, blocky; contains dark gray fine-grained limestone concretions 6-8 | | |

| Unit No. | | Thickness Ft. | In. |
|---|---|---|---|
| | inches thick 3 feet above base; gradational upward through mottled gray and black zone | 5–7 | |
| 52 | Shale, very silty, sandy, gray, finely micaceous, hard, blocky fracture, thick parallel beds, fossiliferous | 12 | |
| 51 | Herrin (No. 6) coal; base concealed; reported to be 8 feet thick | | 6 |

*Geologic section 19.—Outcrop along north bank of Vermilion River, one-fourth mile east of Klein Bridge, NW. ¼ SW. ¼ SW. ¼ sec. 10, T. 31 N., R. 3 E. (Bruce Twp.), Streator quadrangle.*

| Unit No. | | Thickness Ft. | In. |
|---|---|---|---|
| | Pennsylvanian system | | |
| | Brereton cyclothem | | |
| 55 | Shale, gray | 6–10 | |
| 54 | Shale, black, hard, thin-bedded, fossiliferous | 5 | |
| 52 | Shale, very silty, clayey, medium to dark gray, soft, sharply lenticular | 0–7 | |
| 51 | Herrin (No. 6) coal | | |
| | Coal | 3 | 9 |
| | Charcoal, soft, pulverulent | | 1 |
| | Coal | | 8 |
| | Charcoal, soft, pulverulent | | ½–2 |
| | Coal | 1 | |
| | Shale, black, sheety, thin-bedded; contains many plant impressions | | 4 |
| | Shale, gray; contains streaks of coal | | 5 |
| | Coal | | 11 |
| 50 | Clay, very sandy and silty, medium gray | 4 | |
| " | Clay, very sandy and silty; stained with limonite; contains large gypsum crystals | 0–3 | |
| " | Clay, very sandy and silty, light gray, locally contains limestone concretions | 3–8 | |
| 49 | Limestone, dark gray, nonfossiliferous; occurs in rough-surfaced irregular masses; weathers rusty; contains vein-like bands of gray and black clay or shale | 2–4 | |
| 44-48 | Shale, black to dark gray, very carbonaceous, hard, very thin-bedded; partly sheety; contains thin coal streaks | 4 | |
| 43 | Coal, mostly shaly | | 0–5 |
| 41 | Vermilionville sandstone | | |
| | Sandstone, clayey, micaceous, thin-bedded, soft; contains many coaly streaks and is largely black because of abundant carbonaceous plant traces | 1–1½ | |
| | Sandstone, shaly, interbedded gray, brown, and black, micaceous, thin-bedded; contains much carbonaceous material | 4 | |
| | Sandstone, silty, brownish-gray; irregular beds up to 3 feet thick; basal contact wavy | 6–11 | |
| | St. David cyclothem | | |
| 40 | Canton shale | | |
| | Shale, gray, thin-bedded | | 6–12 |
| | Coal, canneloid | | 2 |
| | Shale, gray, thin-bedded, very sandy | 9 | |
| | Coal, canneloid | | 4–8 |
| | Shale, brownish-gray, thin-bedded; base concealed; lower strata exposed only at very low water level | | 6 |

*Geologic section 20.—Outcrop on east bank Vermilion River at greenhouse, SE. ¼ SW. ¼ SW. ¼ sec. 23, T. 31 N., R. 3 E. (Bruce Twp.), Streator quadrangle.*

| Unit No. | | Thickness Ft. | In. |
|---|---|---|---|
| | Pennsylvanian system | | |
| | Brereton cyclothem | | |
| 52 | Shale, very silty, bluish-gray, calcareous along joints; contains silty calcareous concretions | 10 | |
| 51 | Herrin (No. 6) coal; contains thin clay partings | 5 | |
| 48 | Shale, black, hard, sheety; contains plant impressions | | 10 |
| " | Shale, dark gray, flaky | | 3–4 |
| " | Shale, black, hard, sheety | | 6 |
| " | Shale, black, soft | | 3 |
| 47 | Shale, gray, flaky; contains gypsum crystals; limonite-stained along bedding planes | 2 | |
| " | Shale, light gray, thin-bedded | | 6 |
| " | Shale, olive green; limonite-stained along bedding planes | | 2 |
| " | "Ironstone," dense, bluish-gray | | 2 |
| " | Clay, gray | | ½ |
| 46 | Shale, black, hard, thin-bedded, partly sheety in lower part; weathers purple along joints and bedding planes | | 8 |
| 45 | Shale, gray, soft, thin-bedded | | 3 |
| " | Shale, greenish-brown, carbonaceous, thin-bedded | | 10 |
| " | Shale, dark gray, thin-bedded | 1 | |
| 44 | Shale, very dark gray, hard, sheety | | 7 |
| " | Shale, mostly light gray with dark gray layers, gritty, soft, very thin-bedded | 3 | |
| " | Shale, gray, soft, flaky | | 5 |
| 43 | Coal, bright, hard; shaly at base | | 4 |
| " | Clay | | ½ |
| " | Shale, coaly, dark gray, flaky | | 1 |
| " | Shale, coaly, black | | 1 |
| 42 | Clay, dark gray; limonite-stained along joints; faintly bedded | | 8 |
| " | Clay, sandy, light gray, micaceous; dark gray, brownish-weathering rough-surfaced limestone nodules near base | 3 | 10 |
| 41 | Vermilionville sandstone, light gray; massive at top; mostly thin- and medium-bedded; base concealed | 40 | |

*Geologic section 21—Outcrop and strip-coal mine along east bank Vermilion River, SE. ¼ NW. ¼ NW. ¼ sec. 26, T. 31 N., R 3 E. (Bruce Twp)., Streator quadrangle.*

| Unit No. | | Thickness Ft. | Thickness In. |
|---|---|---|---|
| | Pennsylvanian system | | |
| | Brereton cyclothem | | |
| 51 | Herrin (No. 6) coal; top covered | 3 | |
| | Concealed . . . . . . . . . . | 2 | |
| 48 | Shale, black, carbonaceous, hard, locally blocky, sheety; contains *Estheria* . . . . . . | 2 | 8 |
| " | Shale, black and dark gray, very thin-bedded, moderately hard; contains *Leaia* . . . | | 6 |
| 47 | Shale, greenish-gray, very thin-bedded, soft, limonite-stained; contains plant fragments . . . . . . . . . | 1 | 8 |
| 46 | Shale, black, hard, partly sheety, very thin-bedded; contains much gypsum and limonite; contains *Estheria* and *Leaia* | | 11 |
| 45 | Shale, dark gray, hard, *Leaia* abundant . . . . . . . . | | 5 |
| " | Shale, gray, soft, very thin-bedded; contains plant fragments and *Leaia* . . . . | | 4 |
| " | Shale, light greenish-gray, thin-bedded; weathers flaky; contains thin bands of limestone; *Leaia* and *Estheria* abundant in some beds. . . | | 10 |
| 44 | Shale, gray, dark gray and black, thin-bedded; hard with blocky fracture in some places, partly sheety in others; grades laterally to moderately soft shale; *Leaia* and *Estheria* common . . . . | 5 | |
| 43 | Coal . . . . . . . . . . . . . | 1 | 8 |
| 41 | Vermilionville sandstone, gray, micaceous, carbonaceous streaks; base concealed . . | | 4 |

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*Geological section 22.—Outcrop along west bank Vermilion River, NE. ¼ SW. ¼ SW. ¼ sec. 35, T. 31 N., R. 3 E. (Eagle Twp.), Streator quadrangle.*

| Unit No. | | Thickness Ft. | Thickness In. |
|---|---|---|---|
| | Pennsylvanian system | | |
| | Brereton cyclothem | | |
| 51 | Herrin (No. 6) coal with thin clay partings, at base of mine entry . . . . . . . | 1 | |
| 48 | Shale, black, soft, very thin-bedded, contains coal, charcoal streaks, and plant impressions . . . . . . . . . . . | | 5 |
| " | Clay, gray, soft . . . . . . . | | 1 |
| " | Shale, black, as above . . . . | | 6 |
| " | Clay, gray, soft. . . . . . . . | | 1 |
| 47 | Shale, gray, darker at top, beds very thin and indistinct . . | 2 | |
| 46 | Shale, very dark gray, moderately hard, limonite-stained; plant fragments common . | | 4 |
| 45 | Shale, gray, soft, thin-bedded, limonite-stained; contains few ironstone concretions . | 2 | 6 |
| " | Clay, gray, soft . . . . . . . | | 1 |
| " | Shale, gray, soft, thin-bedded, heavily stained with limonite; contains ironstone concretions . . . . . . . . | | 10 |
| 44 | Shale, interbedded dark gray and black, mostly moderately hard; some black bands are sheety . . . . . | 1 | |
| 42 | Clay, gray, noncalcareous, heavily stained with limonite . | 2 | 10 |
| 41 | Vermilionville sandstone, gray, fine-grained, limonite-stained, micaceous; single massive bed; base concealed | 5 | |

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*Geologic section 23.—Road-cut east side of Moon Creek, NW. ¼ NE. ¼ NE. ¼ sec. 11, T. 30 N., R. 3 E. (Reading Twp.), Streator quadrangle.*

| Unit No. | | Thickness Ft. | Thickness In. |
|---|---|---|---|
| | Pennsylvanian system | | |
| | Brereton cyclothem | | |
| 56 | Limestone, gray, dense, irregularly bedded, fossiliferous; partly brecciated and partly conglomeratic; contains dark gray limestone pebbles | 4 | |
| 55 | Shale, light yellowish-gray . . . | 7 | |
| 53 | Sandstone, light gray, very fine-grained, micaceous; occurs in parallel uniform beds 3 to 5 inches thick; base concealed; reported 30 to 35 feet to Herrin (No. 6) coal in mine along Moon Creek . | 10 | |

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*Geologic section 24.—Pit of Purington Paving Brick Co., south of Streator, NE. ¼ sec. 12, T. 30 N., R. 3 E. (Reading Twp.), Streator quadrangle.*

| Unit No. | | Thickness Ft. | Thickness In. |
|---|---|---|---|
| | Pennsylvanian system | | |
| | Brereton cyclothem | | |
| 53 | Sandstone, silty, light gray, micaceous, calcareous, thin-bedded . . . . . . . . . | 5 | |
| 52 | Shale, very silty, sandy, light gray, micaceous; contains limestone concretions . . . | 20–25 | |
| 51 | Herrin (No. 6) coal | | |
| | Coal . . . . . . . . . . . | | 10 |
| | Clay, gray . . . . . . . . | | 0–1 |
| | Coal . . . . . . . . . . . | | 19 |
| | Clay, gray . . . . . . . . | | ½ |
| | Coal . . . . . . . . . . . | | 1½ |
| | Clay, gray and black . . . . | | 3 |
| | Coal . . . . . . . . . . . | | 2 |
| | Clay, gray . . . . . . . . | | ¼–½ |
| | Coal . . . . . . . . . . . | | 2 |
| | Clay, gray; contains thin coal streaks . . . . . . . . . | | 6 |
| | Coal . . . . . . . . . . . | | 11 |
| 50 | Clay, very sandy, light gray, micaceous . . . . . . . . . | 0–5 | |
| 41 | Vermilionville sandstone | | |
| | Shale, sandy, micaceous; grades into fine-grained sandstone; mostly thin-bedded but locally massive; upper part mostly dark brown or black with much carbonaceous matter; base concealed . . . . . . . . | 15 | |

*Geologic section 25.—Pit of Streator Clay Products Co., southeast of Streator, NW. ¼ sec. 7, T. 30 N., R. 4 E. (Newtown Twp.), Streator quadrangle.*

| Unit No. | | Thickness Ft. | In. |
|---|---|---|---|
| | Pennsylvanian system | | |
| | Brereton cyclothem | | |
| 56 | Limestone, gray, weathers light gray, locally brownish-gray, beds 1-6 inches thick, thin shale partings, fossiliferous with *Squamularia perplexa* abundant; top eroded; absent along west side | 6 | |
| 55 | Shale, sandy, light yellowish- or greenish-gray, thin-bedded; absent in west cut | 3 | |
| 53 | Sandstone, gray to brownish-gray, micaceous, very fine-grained, 2-4 inch beds | 2-20 | |
| 52 | Shale, very silty, sandy, light gray, micaceous, thin- to medium-bedded; contains few concretions | 20 | |
| 51 | Herrin (No. 6) coal | | |
| | Coal | 1⅔–2 | |
| | Clay, gray to black | | ¾ |
| | Coal, clay partings | | 1¾ |
| | Clay, gray; contains plant fragments | | 3 |
| | Pyrite | | 0–¾ |
| | Coal | | 2–2½ |
| | Clay, gray, hard; contains coaly streaks | | 4 |
| | Coal | | 3½ |
| | Clay, gray, soft; contains coaly streaks | | 1–2½ |
| | Coal | | 8 |
| 48 | Shale, black, hard, sheety; base concealed | | 2 |

*Geologic section 26.—Bank on southwest side of Vermilion River about 100 yards above the dam, SW. ¼ NW. ¼ sec. 7, T. 30 N., R. 4 E. (Newtown Twp.), Streator quadrangle.*

| Unit No. | | Thickness Ft. | In. |
|---|---|---|---|
| | Pennsylvanian system | | |
| | Sparland cyclothem | | |
| 58 | Copperas Creek sandstone, brownish-gray, weathering buff, slightly calcareous, micaceous, massive-bedded | 1 | |
| | Brereton cyclothem | | |
| 56 | Limestone, gray to pinkish-gray weathering brown, dense to crystalline fossiliferous | 1 | 8 |
| 55 | Shale, sandy, light gray, micaceous, calcareous | | 5 |
| " | Shale, sandy, gray, micaceous, noncalcareous | | 10 |
| " | Shale, light gray, stained greenish-yellow along joints and bedding planes; contains concretions ¼-¾ inch in diameter | | 3 |
| " | Clay, gritty, light gray to brown, noncalcareous; contains some plant material | | 3 |
| " | Shale, silty, grayish-green, stained dark along joints and bedding planes | | 2 |
| " | Shale, silty, grayish-green, contains some mica; grades down into siltstone; contains large concretions | | 9 |
| 52 | Shale, silty, light gray to greenish-gray, 1½-inch beds; base concealed | 1 | |

*Geologic section 27.—Composite section of outcrops along west bank of Vermilion River, N. ½ NW. ¼ sec. 18, T. 30 N., R. 4 E. (Newtown Twp.), Streator quadrangle.*

| Unit No. | | Thickness Ft. | In. |
|---|---|---|---|
| | Pennsylvanian system | | |
| | Gimlet cyclothem | | |
| 62 | Sandstone, gray, cross-bedded, massive; locally cuts through underlying shale and possibly also the coal | 15 | |
| | Sparland cyclothem | | |
| 61 | Farmington shale, gray, soft, thin-bedded | 0–6 | |
| 60 | Sparland (No. 7) coal | 2 | |
| 59 | Clay, dark gray, noncalcareous | 1 | 8 |
| " | Clay, light gray, calcareous | | 10 |
| " | Clay, light gray, limonite-stained, noncalcareous | 1 | 6 |
| " | Clay, light gray, partly mottled with dark gray, noncalcareous; contains limonite-stained splotches | 1 | 3 |
| " | Clay, stained brown with limonite, noncalcareous | | 10 |
| " | Clay, light gray, mottled with dark gray, calcareous | | 11 |
| " | Clay, greenish-gray, calcareous | 3 | |
| 58 | Copperas Creek sandstone, gray, micaceous, thin-bedded; base concealed | 1 | |

*Geologic section 28.—Composite section of outcrops along Vermilion River, W. ½ SE. ¼ sec. 5, T. 29 N., R. 4 E. (Amity Twp.), Streator quadrangle.*

| Unit No. | | Thickness Ft. | In. |
|---|---|---|---|
| | Pennsylvanian system | | |
| | Gimlet cyclothem | | |
| 62 | Sandstone, silty, brownish-gray, micaceous, massive-bedded, friable; weathers buff | 30 | |
| | Sparland cyclothem | | |
| 61 | Farmington shale, dark gray, thin-bedded | 0–6 | |
| 60 | Sparland (No. 7) coal | 0–1¼ | |
| 59 | Clay, gray; base concealed | 6 | |

*Geologic section 29.—Composite section of outcrops along Vermilion River in vicinity of Bradley Bridge, SW. ¼ SE. ¼ sec. 9, T. 29 N., R. 4 E. (Amity Twp.), three-fourths mile south of Streator quadrangle.*

| Unit No. | | Thickness Ft. | In. |
|---|---|---|---|
| | Pennsylvanian system | | |
| | Gimlet cyclothem | | |
| 64 | Lonsdale limestone, gray, fossiliferous; not definitely in place | 3 | 3 |
| 63 | Shale, grayish-green; contains numerous limestone nodules | | 6 |
| " | Shale, dark gray to dark brown | | 4 |
| " | Shale, red, partly mottled with green | | ½ |

| Unit No. | | Thickness Ft. | In. |
|---|---|---|---|
| 63 | *Con't.* | | |
| " | Shale, greenish-gray to buff, slightly silty, calcareous . . | | 7 |
| " | Shale, red, mottled with light green, noncalcareous, soft . | 3 | |
| " | Shale, red, slightly calcareous, soft . . . . . . . . . . | | 7 |
| " | Shale, silty, dark gray . . . . | | 5 |
| " | Shale, sandy, light gray, micaceous; stained yellow along bedding planes and joints . | | 6 |
| " | Shale, sandy, micaceous, gray; grades into underlying sandstone . . . . . . . . . . | 1 | |
| 62 | Sandstone, shaly, gray, micaceous; base concealed . . . | 1–12 | |

*Geologic section 30.—Composite section of outcrops along Waupecan Creek, SW. ¼ NW. ¼ sec. 20, T. 33 N., R. 7 E. (Wauponsee Twp.), Morris quadrangle.*

| Unit No. | | Thickness Ft. | In. |
|---|---|---|---|
| | Pennsylvanian system | | |
| | Brereton cyclothem | | |
| 41 | Vermilionville sandstone, silty, brownish-gray, fine-grained, micaceous, contains carbonaceous streaks; mostly massive, but some thin-bedded; sharply cross-bedded at places; sharp and wavy contact with lower beds . | 25 | |
| | St. David cyclothem | | |
| 40 | Canton shale, gray at top, grading to nearly black in lower 2 feet, medium- to thin-bedded, ironstone concretions 1-3 inches thick occur in persistent layers which are especially abundant 3–10 feet above base; fossils are rare at top but common in calcareous zones near base and on surface of concretions; fauna chiefly gastropods, especially *Phanerotrema grayvillensis* . . . | 14 | |
| 39 | Shale, black, hard, sheety; contains small concretions; *Aviculopecten rectilaterarius* abundant in lower 2 inches . | 2 | |
| 38 | Shale, black, soft, very thin-bedded . . . . . . . . . | | 2–3 |
| 37 | Limestone, shaly, black; contains white fossils . . . . | | 0–2 |
| 36 | Shale, dark gray, very thin-bedded; contains limestone lenses with cone-in-cone structure up to 6 inches thick in shale and along base; *Estheria* and pelecypods common . . . . . . | | 8–10 |
| | Summum cyclothem | | |
| 35 | Covel conglomerate | | |
| | Limestone, dark gray, semilithographic; contains plant impressions; lenses and oval concretions . . . . . . . . | 0–2 | |
| | Limestone conglomerate, fossiliferous; pebbles are light to dark-gray; upper surface of bed locally covered with algal growth with pitted surface; usually 3 to 4 inches thick . . . . . . . . . . . | 0–1 | |
| 29 | Clay, dark greenish-gray; contains thin streak of bright coal locally present at top and in vein-like stringers; contains gray dense limestone nodules mostly with algal structure and deeply etched surface; nodules are locally 2 feet thick and almost completely cut out the clay . . . . . . . . | 2–2½ | |
| 27 | Shale; interbedded and mottled dark gray, black, and green | 1 | |
| 26 | Summum (No. 4) coal . . . . | | 2–4 |
| 25 | Clay, gray . . . . . . . . . | 2 | |
| | Covered . . . . . . . . . . | 3 | |
| 17 | Pleasantview sandstone | | |
| | Siltstone, very calcareous, bluish-gray, hard; massive; base concealed . . . . . | 2 | |

*Geologic section 31.—Composite section of outcrops along Little Vermilion River north and south of bridge and in road-cut east of bridge, in NW. ¼ NW. ¼ sec. 2, T. 33 N., R. 1 E. (LaSalle Twp.), and SW. ¼ SW. ¼ SW. ¼ sec. 35, T. 34 N., R. 1 E. (Dimmick Twp.), LaSalle quadrangle.*

| Unit No. | | Thickness Ft. | In. |
|---|---|---|---|
| | Pennsylvanian system | | |
| | Summum cyclothem | | |
| 17 | Pleasantview sandstone | | |
| | Siltstone, sandy, calcareous, light gray, slightly micaceous, thin-bedded . . . . | 3 | |
| | Lowell cyclothem | | |
| 16 | Shale, gray, soft; sandy at top . | 2 | |
| 15 | Limestone, dark gray, weathering rusty, dense . . . . . | | 0–4 |
| 14 | Shale, gray, soft, thin-bedded . | | 4 |
| " | Shale, very dark gray, soft . . | 5 | |
| " | Shale, light gray, soft, thin-bedded; contains discoid rusty-weathering gray limestone concretions; fossiliferous with *Mesolobus mesolobus*, *Ambocoelia planoconvexa*, *Marginifera muricatina* abundant . . . . . . . . | 9 | |
| 13 | Limestone, dark gray, pyritic, fossiliferous; weathers brown . . . . . . . . . | | 0–2 |
| 12 | Shale, black, soft, thin-bedded; white shells of *Chonetes flemingi*, *Mesolobus mesolobus*, *Linoproductus prattenianus*, *Marginifera muricatina*, *Ambocoelia planoconvexa*, *Juresania sp.* abundant in upper part and *Aviculopecten rectilaterarius* abundant in lower part . . | 2 | |
| 9 | Siltstone, light chocolate brown, micaceous; fossils, poorly preserved . . . . . . . . | ⅔–3 | |

| Unit No. | | Thickness Ft. | Thickness In. |
|---|---|---|---|
| | Liverpool cyclothem | | |
| 8 | Shale, black or dark gray, soft | 0–1 | |
| " | Limestone, very dark gray, pyritic; weathers rusty, fossiliferous, locally crowded with pelecypods | | 2–10 |
| " | Shale, black, soft | | 0–10 |
| 7, 8 | Shale, sandy, gray; contains large septarian limestone concretions, mostly in upper 3 feet | 7 | |
| 6 | Shale, black, hard, sheety; base concealed | 1 | |

*Geologic section 32.—South bank Vermilion River south of Deer Park, NW. ¼ SE. ¼ NE. ¼ sec. 31, T. 33 N., R. 2 E. (Deer Park Twp.), LaSalle quadrangle.*

| Unit No. | | Thickness Ft. | Thickness In. |
|---|---|---|---|
| | Pennsylvanian system | | |
| | Sparland cyclothem | | |
| 58 | Copperas Creek sandstone, shaly, brownish-gray; interbedded with shale, sandy, micaceous, thin-bedded | 20 | |
| | Brereton cyclothem | | |
| 56 | Brereton limestone | | |
| | Limestone, gray, dense, fossiliferous | ½–1 | |
| | Shale, light gray, thin-bedded | | 6 |
| | Limestone, brownish-gray, dense, fossiliferous | | 8–10 |
| | Sandstone, light gray, charcoal streaks; contains large flakes of mica | | 6 |
| | Clay, purplish-gray | | 0–1 |
| | Clay, mottled light and dark gray | 1 | |
| | Clay, mottled pink and light and dark gray | 3 | |
| | Clay, grayish-yellow | | 6 |
| | Clay, mottled light red and gray | | 8 |
| | Clay, red | 1 | |
| | Limestone, reddish-gray, nodular | | 2 |
| | Not exposed | 2 | |
| 55? | Shale, sandy, light greenish-gray | 10 | |
| 53 | Sandstone, shaly, brownish-gray, micaceous, thin-bedded; grades into underlying shale | 19 | |
| 52 | Shale, bluish-gray, noncalcareous, very thin-bedded; contains great abundance of plant fragments | 6 | 6 |
| " | Shale, black, hard, flaky | | 3 |
| 51 | Herrin (No. 6) coal | | |
| | Coal, hard | 1 | 10 |
| | Coal, shaly | | 9 |
| | Clay, purplish-gray, slightly bedded, contains streaks of charcoal | | 5 |
| | Coal, shaly, pyritic | | 5 |
| 41 | Vermilionville sandstone | | |
| | Shale, dark gray, silty, laminated; grades into underlying sandstone | | 8 |
| | Sandstone, silty, gray, micaceous; upper 2 feet is thin-bedded but remainder has many thick, massive beds and is cross-bedded | 38 | |
| | St. David cyclothem | | |
| 40 | Canton shale, gray, medium-bedded | 7 | |
| 39 | Shale, black, hard, sheety; contains many small limestone concretions; *Aviculopecten rectilaterarius* abundant at base | 2 | 9 |
| 38 | Shale, black, soft | | 0–2 |
| 37 | Limestone, shaly, black; contains white fossils | | 0–1 |
| 36 | Shale, dark gray, soft, thin-bedded | | 0–4 |
| | Summum cyclothem | | |
| 35 | Covel conglomerate | | 0–7 |
| 28 | Hanover limestone, argillaceous, gray, nodular, fossiliferous, partly weathers buff; locally has shale partings up to 5 inches | 1–1½ | |
| 27 | Shale, greenish-gray, poorly bedded, fossiliferous; contains many limestone nodules | 3–4 | |
| " | Shale, mottled dark greenish-gray and black, thin-bedded | 1 | |
| " | Limestone, sandy, gray | | 0–2 |
| " | Shale, black, soft | | 1 |
| | Covered | 15 | |
| 17 | Pleasantview sandstone | | |
| | Siltstone, sandy, calcareous, gray, single ledge | 1 | 6 |
| | Lowell cyclothem | | |
| 16 | Shale, sandy, gray, soft; base concealed | 2 | |

*Geologic section 33.—Composite section of south and west bank Vermilion River one-half mile west of Lowell, SE. ¼ SW. ¼ sec. 8, T. 32 N., R. 2 E. (Vermilion Twp.), LaSalle quadrangle.*

| Unit No. | | Thickness Ft. | Thickness In. |
|---|---|---|---|
| | Pleistocene system | | |
| | Soil, sand, gravel, till (undifferentiated | 45 | |
| | Pennsylvanian system | | |
| | Brereton cyclothem | | |
| 41 | Vermilionville sandstone | | |
| | Sandstone, brownish-gray, thin-bedded; interbedded with sandy shale; contains many black carbonaceous partings | 10 | |
| | Sandstone, brown, fine-grained, poorly sorted; occurs in one massive bed | 4 | 2 |
| | St. David cyclothem | | |
| 40 | Canton shale, gray; lower part fossiliferous; contains layers of discoid septarian fossiliferous ironstone concretions; gastropods abundant; grades into underlying shale | 14 | 6 |
| 39 | Shale, black, hard, sheety, slaty; contains small limestone concretions; *Aviculopecten rectilaterarius* abundant at base | 1 | 8 |

| Unit No. | | Thickness Ft. | In. |
|---|---|---|---|
| 38 | Shale, black, soft, thin-bedded | | 2 |
| 37 | Limestone, shaly, black; abundant white fossils | | 0–1 |
| 36 | Shale, dark gray, calcareous, thin-bedded; *Estheria* abundant | | 2 |
| | Summum cyclothem | | |
| 35 | Covel conglomerate, pyritic matrix | | 0–1 |
| 29 | Clay, greenish-gray, calcareous; many small rough-surfaced limestone nodules form an almost continuous layer near middle; fossiliferous, with *Marginifera* abundant | 2 | 10 |
| 28 | Hanover limestone, argillaceous, greenish-gray, nodular; very fossiliferous, with Productids and crinoid stems abundant; grades upward to clay | 1¾–2¼ | |
| 27 | Shale, interbedded black and green, thin-bedded | | 8 |
| " | Shale, siliceous, black, hard, blocky; beds variable from thin to thick; contains beds of laminated dark gray and black limestone; large spherical gray limestone concretions locally present | 4 | 7 |
| 25 | Clay, gray; calcareous except upper 8 inches | 6–8 | |
| 23 | Limestone, light gray, nodular; weathers whitish | | 0–6 |
| 21 | Shale, black, soft | | ¼ |
| 20 | Clay, light gray, plastic | | 6 |
| 19 | Shale, black, soft | | ¼ |
| 18 | Clay, gritty, finely micaceous; mixed dark greenish-gray, brownish-gray, and black | 1 | |
| " | Clay, dark purplish-gray; has faint bedding planes | | 0–6 |
| 17 | Pleasantview sandstone | | |
| | Shale, sandy, light greenish-gray, similar to bed below but is noncalcareous | ½–1½ | |
| | Siltstone, sandy, calcareous, clayey, light greenish-gray, hard, beds 1 inch to 1 foot; large rusty splotches on weathered surface | 3 | |
| | Lowell cyclothem | | |
| 16 | Shale, light greenish-gray, finely micaceous; very sandy at top, less sandy at base; contains small nodules of sandy gray limestone which weathers rusty | 4 | |
| 15 | Limestone, silty, light greenish-gray, micaceous | | 7 |
| 14 | Shale, light gray, soft, medium-bedded; slightly gritty at top | 4 | 8 |
| " | Shale, mottled red and green, soft | | 0–8 |
| " | Shale, light greenish-gray, medium-bedded | | 9–12 |
| 13 | Limestone, light gray, weathers brown, fossiliferous, with *Marginifera muricatina* very abundant, *Mesolobus mesolobus*, *Ambocoelia planoconvexa* | | 5 |
| 12 | Shale, gray, soft, thin-bedded; small discoid gray (rusty-weathering) limestone concretions numerous in lower 3 feet, rare above; fossiliferous | 5 | 6 |
| " | Shale, dark gray streaked with limonite, fossiliferous | | 3 |
| " | Shale, dark gray, thin-bedded; contains white fossils, especially *Mesolobus mesolobus*, *Marginifera muricatina*, *Neospirifer triplicatus* | | 3 |
| 11 | Coal, partings of black sheety shale | | 0–5 |
| 10 | Clay, lenticular; the upper 8 inches noncalcareous | 0–3½ | |
| 9 | Siltstone, sandy, calcareous, gray to dark gray, micaceous; plant impressions and charcoal streaks common | | 6 |
| | Liverpool cyclothem | | |
| 8 | Clay, gray, soft, plastic | | 0–8 |
| " | Shale, sandy, dark gray, micaceous, thick-bedded | 10 | |
| " | Limestone, dark gray, semi-lithographic, septarian; grades into shale above and below | 0–1 | |
| " | Shale, sandy, dark gray, micaceous, thick-bedded | 2 | |
| 7 | Limestone, dark gray, semi-lithographic, septarian; few fossils | 0–1½ | |
| " | Shale, sandy, dark gray, micaceous, thick-bedded | 2 | 8 |
| 6 | Shale, black, hard, sheety; contains large concretions of dark gray limestone | 1 | 10 |
| 5 | Francis Creek shale, light gray, soft, thin-bedded; few limestone concretions | 15 | 4 |
| 4 | LaSalle (No. 2) coal; contains thin lenticular pyrite partings; generally not exposed | 3 | 2 |
| 3 | Clay, gray, noncalcareous; generally not exposed; base concealed | | 6 |

*Geologic section 34.—Outcrop along stream, one and one-fourth miles east of Cambridge, NW. ¼ SE. ¼ SE. ¼ sec. 9, T. 15 N., R. 3 E., (Cambridge Twp.), Geneseo quadrangle.*

| Unit No. | | Thickness Ft. | In. |
|---|---|---|---|
| | Pennsylvanian system | | |
| | St. David cyclothem | | |
| 40 | Canton shale, light gray, thin-bedded; contains small discoid ironstone concretions 2-6 inches long, 1 inch thick | 20 | |
| 39 | Shale, black, hard, sheety; *Aviculopecten rectilaterarius* abundant near base | 1 | |
| 38 | Shale, black, soft, thin-bedded | | 1–3 |

| *Unit No.* | | *Thickness Ft.* | *In.* |
|---|---|---|---|
| 37 | Limestone, shaly, black; contains abundant white fossils | | 2–5 |
| 36 | Clay, gray, calcareous; contains carbonaceous plant traces . | | 11 |
| | Summum cyclothem | | |
| 35 | Covel conglomerate | | |
| | Limestone and limestone conglomerate; limestone is medium to dark gray, dense, argillaceous, nonfossiliferous, in lenses maximum 10 feet long, 1 foot thick, locally split in two layers by 2 inches shale, grades into shale; conglomerate locally present in lenses maximum ½ inch thick, fine-grained, pyritic matrix, rarely present . . . . . . . . . . | 0–1 | |
| 34 | Shale, dark gray, nearly black, thin-bedded; contains carbonaceous plant fossils . . | 1 | 3 |
| 30 | Limestone conglomerate; contains many pebbles covered with algal growths with pitted surfaces . . . . . | | 0–7 |
| " | Limestone, dark gray, dense; occurs in lenses 2 to 3 feet long, 1 foot thick . . . . | 0–1 | |
| 29 | Clay, gray, slightly gritty, noncalcareous, faintly bedded . | 3 | |
| 27? | Limestone, light gray, nodular, limonitic nonfossiliferous . | 0–1 | |
| 17? | Shale, sandy, light gray, thick-bedded; contains limonite streaks; base concealed . . | 5 | |

*Geologic section 35.—Auger boring, NW. ¼ SE. ¼ SW. ¼ sec. 27, T. 35 N., R. 6 E. (Big Grove Twp.), Marseilles quadrangle.*

| | *Thickness Ft.* | *In.* |
|---|---|---|
| Pleistocene system | | |
| Wisconsin stage | | |
| Undifferentiated[1] | | |
| Humus, silty, black . . . | 1 | 3 |
| Clay, brownish-gray, noncalcareous . . . . . . | 1 | 8 |
| Tazewell substage | | |
| Marseilles drift—Lake Lisbon deposits | | |
| Clay, sandy, brownish-gray, noncalcareous, stratified . . . . . . . | | 10 |
| Silt, clayey, light brown, noncalcareous, laminated | 1 | 5 |
| Sand, yellow and gray, fine-grained . . . . . . . . | | 8 |
| Silt, stratified; contains few small pebbles . . . . . | | 2 |
| Marseilles drift | | |
| Till, silty, pebbly; base not reached . . . . . . . . . | 3 | 2 |

[1]The undifferentiated Wisconsin deposits include the weathered materials, mostly loess, which are in part Tazewell, Cary, and Mankato in age and cannot be separated.

*Geologic section 36.—Auger boring, SW. ¼ SE. ¼ SW. ¼ sec. 29, T. 35 N., R. 6 E. (Big Grove Twp.), Marseilles quadrangle.*

| | *Thickness Ft.* | *In.* |
|---|---|---|
| Pleistocene system | | |
| Wisconsin stage | | |
| Undifferentiated | | |
| Humus, clayey, black . . | 1 | 10 |
| Clay, black, noncalcareous | | 7 |
| Clay, brown, noncalcareous | | 7 |
| Clay, gray with brown streaks, noncalcareous; contains few small pebbles . . . . . . . . . . | 2 | 5 |
| Clay, as above but without brown streaks . . . . . | | 4 |
| Clay, as above; pebbles more abundant . . . . | | 8 |
| Tazewell substage | | |
| Marseilles drift | | |
| Gravel; base not reached . | | 2 |

*Geologic section 37.—Auger boring, SE. corner NE. ¼ NE. ¼ sec. 32, T. 35 N., R. 6 E. (Big Grove Twp.), Marseilles quadrangle.*

| | *Thickness Ft.* | *In.* |
|---|---|---|
| Pleistocene system | | |
| Wisconsin stage | | |
| Undifferentiated | | |
| Humus, silty, black . . . | 1 | 6 |
| Clay, silty, gray, noncalcareous . . . . . . . . . . | 1 | 7 |
| Tazewell substage | | |
| Marseilles drift—Lake Lisbon deposits | | |
| Silt, loess-like, sandy, yellow, calcareous . . . . | 1 | |
| Clay, brownish-gray, calcareous . . . . . . . . . | 1 | 7 |
| Clay (till?), calcareous, stratified (?); contains sandy streaks; pebble at bottom . . . . . . . . | | 11 |

*Geologic section 38.—Road-cut in east bluff of Fox River, SW. ¼ SE. ¼ SE. ¼ sec. 20, T. 35 N., R. 5 E. (Mission Twp.), Marseilles quadrangle.*

| | *Thickness Ft.* | *In.* |
|---|---|---|
| Pleistocene system | | |
| Wisconsin stage | | |
| Undifferentiated | | |
| Humus, silty, brown . . . | 1 | |
| Silt, brown, noncalcareous; pebbles in lower foot . | 3 | |
| Tazewell substage | | |
| Marseilles drift | | |
| Gravel, weathered . . . . | | 6 |
| Gravel, many half-inch pebbles . . . . . . . . . | 10 | |
| Bloomington drift | | |
| Sand, fine gravel, and lenses of pink till interbedded . | 8 | |
| Shelbyville drift | | |
| Lake Kickapoo silt and clay, yellow and pink, laminated, contorted; upper surface deeply channeled; basal surface irregular . | 12–15 | |

| | Thickness Ft. | In. |
|---|---|---|
| Sand and fine gravel, cross-bedded | 10–12 | |
| Illinoian (?) stage | | |
| Till, silty, gravelly, yellow-brown; contains coal fragments as large as 6 inches in diameter; contains lenses of gravel and sand | 7 | |
| Gravel, fine, mostly one-fourth inch pebbles; on St. Peter sandstone | 5 | |

*Geologic section 39.—Bank along north side of middle fork of Mission Creek, northeast of bridge, NW. ¼ SE. ¼ NE. ¼ sec. 21, T. 35 N., R. 5 E. (Mission Twp.), Marseilles quadrangle.*

| | Ft. | In. |
|---|---|---|
| Pleistocene system | | |
| Wisconsin stage | | |
| Undifferentiated | | |
| Humus, silty, brown | 1 | |
| Silt, brown, noncalcareous | 2 | |
| Tazewell substage | | |
| Marseilles drift | | |
| Gravel, coarse | | 0–6 |
| Bloomington drift | | |
| Till, pink, calcareous | 4 | |
| Gravel, coarse, bouldery, grading to sand, yellow, fine-grained, well sorted | 1–3 | |
| Till, pink; lenses of sand and gravel in upper 5 feet; pebbles rare in lower 5 feet | 10 | |
| Shelbyville drift | | |
| Silt, light brown, calcareous, laminated | | 0–6 |
| Gravel and sand; upper 1-2 feet mostly coarse sand | 6 | |
| Sangamon stage | | |
| Silt, light bluish-gray, calcareous | | 1–2 |
| Peat, black, faintly laminated; contains abundance of wood fragments | 1 | 1 |
| Peat, silty, very dark gray; contains little wood | 3–4 | |
| Illinoian stage | | |
| Till, sandy, dark greenish-gray, noncalcareous; contains many chert pebbles | 3–5 | |
| Till, sandy, greenish-gray, slightly calcareous; contains soft limestone pebbles; base concealed | 0–2 | |

*Geologic section 40.—Auger boring, SW. ¼ SE. ¼ SE. ¼ sec. 1, T. 34 N., R. 5 E. (Miller Twp.), Marseilles quadrangle.*

| | Thickness Ft. | In. |
|---|---|---|
| Pleistocene system | | |
| Wisconsin stage | | |
| Undifferentiated | | |
| Humus, silty, black | 1 | 6 |
| Silt, clayey, brown, noncalcareous | 1 | |
| Silt, yellow, noncalcareous | | 11 |
| Tazewell substage | | |
| Marseilles drift | | |
| Silt (weathered till), yellow, noncalcareous; contains few small pebbles | | 9 |
| Till, silty, pebbly, calcareous; base not reached | | 2 |

*Geologic section 41.—Auger boring, SE. corner SW. ¼ SW. ¼ sec. 3, T. 34 N., R. 6 E. (Nettle Creek Twp.), Marseilles quadrangle.*

| | Ft. | In. |
|---|---|---|
| Pleistocene system | | |
| Wisconsin stage | | |
| Undifferentiated | | |
| Soil, black | 1 | 8 |
| Silt, light brown, noncalcareous | 1 | 4 |
| Cary substage | | |
| Valparaiso drift— Lake Wauponsee deposits | | |
| Silt, yellow, noncalcareous, stratified | | 8 |
| Sand, yellow, pebbly | | 11 |
| Sand, clayey, calcareous | 2 | 1 |
| Tazewell substage | | |
| Marseilles drift | | |
| Till, silty, pebbly, light brown; base not reached | | 1 |

*Geologic section 42.—Bank along Nettle Creek, NE. ¼ SE. ¼ SE. ¼ sec. 21, T. 34 N., R. 6 E. (Nettle Creek Twp.), Marseilles quadrangle.*

| | Ft. | In. |
|---|---|---|
| Pleistocene system | | |
| Wisconsin stage | | |
| Undifferentiated | | |
| Humus and silt, dark, noncalcareous | 2 | |
| Cary substage | | |
| Valparaiso drift—Lake Wauponsee deposits | | |
| Clay, gray | 1 | 6 |
| Gravel | | 6 |
| Silt, light yellow, calcareous | 1 | 6 |
| Tazewell substage | | |
| Marseilles drift | | |
| Till, brown, calcareous; base concealed | 3 | |

*Geologic section 43.—Bank along Nettle Creek, SW. ¼ SW. ¼ NW. ¼ sec. 22, T. 34 N., R. 6 E. (Nettle Creek Twp.), Marseilles quadrangle.*

| | Ft. | In. |
|---|---|---|
| Pleistocene system | | |
| Wisconsin stage | | |
| Undifferentiated | | |
| Humus, silty brown | 1 | |
| Clay, silty, brown, noncalcareous | 3 | |
| Cary substage | | |
| Valparaiso drift—Lake Wauponsee deposits | | |
| Sand, dark brown | | 6 |
| Gravel, brown | | 3–6 |
| Silt, yellow, small pebbles | | 6 |
| Silt, yellow, interbedded with sand at base | 1 | |
| Clay and silt, interbedded, light brown | 5–6 | |
| Covered | 2 | |
| Tazewell substage | | |
| Marseilles drift | | |
| Till, dark gray; base concealed | 3 | |

*Geologic section 44.—Bank along Nettle Creek, NW. ¼ SE. ¼ NE. ¼ sec. 22, T. 34 N., R. 6 E. (Nettle Creek Twp.), Marseilles quadrangle.*

| | Thickness Ft. | In. |
|---|---|---|
| Pleistocene system | | |
| Wisconsin stage | | |
| Undifferentiated | | |
| Humus, silty, black | 1 | 6 |
| Silt, brown, noncalcareous | 1 | |
| Cary substage | | |
| Valparaiso drift—Lake Wauponsee deposits | | |
| Clay, silty, brown | | 6 |
| Silt, clayey, brown | | 6 |
| Silt, gray, stratified | 1 | 3 |
| Gravel, large pebbles | | 4–6 |
| Clay, stratified | | 6 |
| Tazewell substage | | |
| Marseilles drift | | |
| Silt, pebbly (till?); base concealed | 1 | |

*Geologic section 45.—Auger boring, NW. corner sec. 26, T. 34 N., R. 6 E. (Nettle Creek Twp.), Marseilles quadrangle.*

| | Thickness Ft. | In. |
|---|---|---|
| Pleistocene system | | |
| Wisconsin stage | | |
| Undifferentiated | | |
| Humus, silty, black | 1 | |
| Clay, dark gray, noncalcareous | 2 | |
| Tazewell substage | | |
| Valparaiso drift—Lake Wauponsee deposits | | |
| Silt, light yellowish-gray, calcareous | 1 | |
| Silt, yellowish-brown, interbedded with sand, gray, coarse-grained, well sorted | | 6 |
| Marseilles drift | | |
| Till, silty, pebbly, yellowish-gray; base not reached | | 6 |

*Geologic section 46.—Auger boring, SW. corner sec. 28, T. 34 N., R. 6 E. (Nettle Creek Twp.), Marseilles quadrangle.*

| | Thickness Ft. | In. |
|---|---|---|
| Pleistocene system | | |
| Wisconsin stage | | |
| Undifferentiated | | |
| Humus, silty, black | 1 | |
| Clay, gray, noncalcareous | 1 | |
| Clay, gray, noncalcareous, streaked with limonite | 1 | |
| Cary substage | | |
| Valparaiso drift—Lake Wauponsee deposits | | |
| Gravel, brown, fine-grained, calcareous; contains much coarse sand | 1 | |
| Tazewell substage | | |
| Marseilles drift | | |
| Till, brown, calcareous; base not reached | | 6 |

*Geologic section 47.—Gravel pit in north bluff of Illinois Valley, NE. ¼ SE. ¼ NW. ¼ sec. 21, T. 33 N., R. 5 E. (Manlius Twp.), Marseilles quadrangle.*

| | Thickness Ft. | In. |
|---|---|---|
| Pleistocene system | | |
| Wisconsin stage | | |
| Undifferentiated | | |
| Humus, silty | 1 | |
| Silt, gravelly, brown | 0–3 | |
| Tazewell substage | | |
| Marseilles drift | | |
| Lake Illinois deltal gravel, bouldery, coarse, angular, poorly sorted, in beds dipping southwest 15 degrees; contains many balls of greenish-gray till; only present at east end of pit | 0–10 | |
| Till, clayey, greenish-gray; contains lenses of gravel | 0–4 | |
| Bloomington drift | | |
| Lake Illinois clay, greenish-gray, laminated | 0–2 | |
| Till, pebbly, light brown, upper part laminated | 0–6 | |
| Silt, brown, and sand, fine-grained; bedding contorted; very locally present; base irregular | 0–3 | |
| Till, blue in east part of cut, pink in west | 3 | |
| Shelbyville drift—Lake Kickapoo deposits | | |
| Sand, silty, light brown, fine-grained, cross-bedded, laminated; grades downward to silt | 4–6 | |
| Silt, brownish-gray, very thin laminae | 2–5 | |
| Clay, silty, pink and brown, laminated | 1 | |
| Shelbyville drift | | |
| Gravel and sand, cross-bedded, pebbles well rounded; base concealed at water level | 30 | |

*Geologic section 48.—West bank of stream south of Seneca, NE. ¼ SE. ¼ NE. ¼ sec. 35, T. 33 N., R. 5 E. (Brookfield Twp.), Marseilles quadrangle.*

| | Thickness Ft. | In. |
|---|---|---|
| Pleistocene system | | |
| Wisconsin stage | | |
| Undifferentiated | | |
| Humus, silty, brown | 1 | |
| Cary substage | | |
| Valparaiso drift — Kankakee Torrent deposits | | |
| Sand, brown | 2 | |
| Tazewell substage | | |
| Marseilles drift | | |
| Till, clayey, dark gray, calcareous; contains lenses of sand and few boulders | 10 | |
| Bloomington drift | | |
| Lake Illinois silt and clay interbedded, dark to light gray | 6 | |
| Till, brown, calcareous | 2 | |

| | Thickness Ft. | In. |
|---|---|---|
| Shelbyville drift—Lake Kickapoo deposits | | |
| Silt and clay, dark gray, laminated | 1–2 | |
| Clay, silt, and sand, beds broken forming breccia-like mixture | 1–2 | |
| Shelbyville drift | | |
| Till, silty, yellow, brown, and gray; contains irregular patches of sand | 10 | |
| Gravel, sandy, cross-bedded; contains lenses of coarse-grained, well-sorted sand | 15 | |
| Illinoian (?) stage | | |
| Till, dark purplish-gray, calcareous, dense; contains limonite streaks; base concealed | 3 | |

*Geologic section 49.—Gully on east side of Deadly Run southeast of Seneca, NW. ¼ NE. ¼ NE. ¼ sec. 36, T. 33 N., R. 5 E. (Brookfield Twp.), Marseilles quadrangle.*

| | Ft. | In. |
|---|---|---|
| Pleistocene system | | |
| Wisconsin stage | | |
| Undifferentiated | | |
| Humus, silty | 1 | |
| Clay, greenish-gray, soft | 1 | 6 |
| Tazewell substage | | |
| Bloomington drift—Lake Illinois deposits | | |
| Clay, silty, stratified; contains fine-grained sand streaks | 6 | |
| Silt, clayey, brownish-gray, stratified; contains few small pebbles | 1 | |
| Sand, well-bedded; gravelly in streaks | | 9 |
| Bloomington drift | | |
| Till, sandy, gray, hard; contains many pebbles and boulders | 3 | |
| Shelbyville drift—Lake Kickapoo deposits | | |
| Silt, brownish-gray, laminated | 5–6 | |
| Gravel, fine | 1 | |
| Silt, brown, laminated | 1 | 6 |
| Sand, brownish-gray, pebbly | 4 | |
| Gravel, well-bedded, pebbles mostly less than 2 inches in diameter | 5 | 6 |
| Silt, light brown, well-bedded | 3 | |
| Sand, medium- to coarse-grained, cross-bedded; base concealed | 3 | |

*Geologic section 50.—Auger boring, NE. ¼ NW. ¼ NE. ¼ sec. 27, T. 35 N., R. 4 E. (Serena Twp.), Ottawa quadrangle.*

| | Thickness Ft. | In. |
|---|---|---|
| Pleistocene system | | |
| Wisconsin stage | | |
| Undifferentiated | | |
| Humus, and silt, dark gray at top, light gray at base | 1 | 6 |
| Silt, light gray, noncalcareous | 3 | 3 |
| Silt, as above, limonitic | 1 | |
| Silt, black, noncalcareous | | 1 |
| Silt, light gray, noncalcareous | | 1 |
| Tazewell substage | | |
| Farm Ridge drift | | |
| Till, pebbly, brown; base not reached | 2 | |

*Geologic section 51.—Auger boring, NE. corner sec. 27, T. 35 N., R. 3 E. (Freedom Twp.), Ottawa quadrangle.*

| | Ft. | In. |
|---|---|---|
| Pleistocene system | | |
| Wisconsin stage | | |
| Undifferentiated | | |
| Humus and silt, brown at top, light gray at base | 1 | |
| Silt, light gray, noncalcareous | 2 | |
| Silt, black, slightly calcareous | | 2 |
| Silt, very light gray, calcareous | 1 | |
| Silt, as above, limonitic streaks | 1 | |
| Tazewell substage | | |
| Farm Ridge drift | | |
| Till, pebbly, brown, calcareous; base not reached | | 6 |

*Geologic section 52.—Auger boring, SE. corner sec. 13, T. 35 N., R. 2 E. (Ophir Twp.), Ottawa quadrangle.*

| | Ft. | In. |
|---|---|---|
| Pleistocene system | | |
| Wisconsin stage | | |
| Undifferentiated | | |
| Humus, silty | 2 | |
| Silt, light reddish-brown at top, grades to light gray at base, limonitic, noncalcareous | 6 | |
| Clay, mucky, black, noncalcareous; contains few small pebbles | 2 | |
| Tazewell substage | | |
| Farm Ridge drift | | |
| Sand, red, coarse-grained | 1 | 6 |
| Till, brown, noncalcareous | | 3 |
| Till, brown, calcareous; base not reached | | 3 |

*Geologic section 53.—Auger boring, one-tenth mile east of SE. corner sec. 16, T. 35 N., R. 2 E. (Ophir Twp.), Ottawa quadrangle.*

| | Ft. | In. |
|---|---|---|
| Pleistocene system | | |
| Wisconsin stage | | |
| Undifferentiated | | |
| Humus, silty, black | 2 | |
| Silt, brownish-gray, limonitic, noncalcareous | 3 | 6 |
| Silt, light gray, limonitic, noncalcareous | 5 | |
| Silt, dark gray to black, noncalcareous; contains much organic material and a few pebbles | 3 | |

| | Thickness Ft. | In. |
|---|---|---|
| Tazewell substage | | |
| Farm Ridge drift | | |
| Gravel, weathered; base not reached | | 6 |

*Geologic section 54.—Auger boring, NE. corner SE. ¼ sec. 25, T. 35 N., R. 2 E. (Ophir Twp.), Ottawa quadrangle.*

| | Ft. | In. |
|---|---|---|
| Pleistocene system | | |
| Wisconsin stage | | |
| Undifferentiated | | |
| Humus, silty, black | 1 | |
| Clay, dark gray, noncalcareous | 2 | |
| Clay, brown, noncalcareous | 1 | |
| Clay, light gray, slightly calcareous; contains limonitic streaks | | 6 |
| Clay, mucky, black, slightly calcareous; contains small pebbles | | 6 |
| Silt, gray, calcareous; contains limonitic streaks | 1 | |
| Tazewell substage | | |
| Farm Ridge drift | | |
| Sand, fine-grained at top, coarse-grained at base; base on gravel | 1 | |

*Geologic section 55.—Auger boring, NE. corner SE. ¼ SE. ¼ sec. 27, T. 35 N., R. 2 E. (Ophir Twp.), Ottawa quadrangle.*

| | Ft. | In. |
|---|---|---|
| Pleistocene system | | |
| Wisconsin stage | | |
| Undifferentiated | | |
| Humus, silty, light brown | | 6 |
| Tazewell substage | | |
| Farm Ridge drift | | |
| Till, silty, pebbly, light brown, noncalcareous | | 9 |
| Till, silty, pebbly, light brown, calcareous; base not reached | | 3 |

*Geologic section 56.—Auger boring, NW. corner NE. ¼ NE. ¼ sec. 28, T. 35 N., R. 2 E. (Ophir Twp.), Ottawa quadrangle.*

| | Ft. | In. |
|---|---|---|
| Pleistocene system | | |
| Wisconsin stage | | |
| Undifferentiated | | |
| Humus, silty | 1 | |
| Silt, gray, limonitic, noncalcareous | 2 | |
| Silt, black, noncalcareous | | 3 |
| Silt, gray, noncalcareous | 1 | 6 |
| Tazewell substage | | |
| Farm Ridge drift | | |
| Sand, limonitic | | 6 |
| Silt, sandy, noncalcareous | 1 | |
| Cropsey drift | | |
| Till, brown, calcareous; base not reached | 1 | |

*Geologic section 57.—Auger boring, SE. corner sec. 28, T. 35 N., R. 2 E. (Ophir Twp.), Ottawa quadrangle.*

| | Ft. | In. |
|---|---|---|
| Pleistocene system | | |
| Wisconsin stage | | |
| Undifferentiated | | |
| Humus, silty, dark brown | 1 | |
| Silt, brownish-gray; limonitic at base; noncalcareous except lower 2 inches slightly calcareous | 2 | 6 |
| Silt, clayey, black, slightly calcareous, plastic; contains a few small pebbles | | 4 |
| Silt, light gray, weakly calcareous; contains limonitic streaks | 1 | |
| Tazewell substage | | |
| Cropsey drift | | |
| Till, sandy and silty, gray, calcareous | 1 | 6 |
| Till, clayey, gray, calcareous; base not reached | | 6 |

*Geologic section 58.—Auger boring, NE. corner SE. ¼ sec. 34, T. 35 N., R. 2 E. (Ophir Twp.), Ottawa quadrangle.*

| | Ft. | In. |
|---|---|---|
| Pleistocene system | | |
| Wisconsin stage | | |
| Undifferentiated | | |
| Humus and silt, black at top, brownish-gray at base | 1 | 6 |
| Clay, dark bluish-gray, limonitic, noncalcareous | 3 | 6 |
| Tazewell substage | | |
| Farm Ridge drift | | |
| Sand, gray, coarse-grained, few pebbles | | 6 |
| Till, dark brown, calcareous; base not reached | 1 | 6 |

*Geologic section 59.—Auger boring, SW. corner sec. 34, T. 35 N., R. 2 E. (Ophir Twp.), Ottawa quadrangle.*

| | Ft. | In. |
|---|---|---|
| Pleistocene system | | |
| Wisconsin stage | | |
| Undifferentiated | | |
| Humus, dark brownish-gray | 1 | |
| Silt, clayey, light yellowish-brown, noncalcareous; contains a few chert pebbles | 2 | |
| Tazewell substage | | |
| Farm Ridge drift | | |
| Till, silty, yellow, calcareous; base not reached | | 6 |

*Geologic section 60.—Auger boring, SW. corner sec. 12, T. 34 N., R. 2 E. (Waltham Twp.), Ottawa quadrangle.*

| | Ft. | In. |
|---|---|---|
| Pleistocene system | | |
| Wisconsin stage | | |
| Undifferentiated | | |
| Humus, dark brown | 1 | |
| Silt, yellow, slightly calcareous | 2 | 6 |
| Silt, yellowish-gray, calcareous; contains calcareous concretions | 1 | |
| Cary substage | | |
| Valparaiso drift—Lake Ottawa deposits | | |
| Silt, slightly sandy, yellowish-brown, calcareous | 1 | 6 |
| Sand, silty, medium-grained, limonitic | | 3 |

| | Thickness Ft. | In. |
|---|---|---|
| Tazewell substage | | |
| Farm Ridge drift | | |
| Till, pebbly, dark gray, calcareous; base not reached | 1 | |

*Geologic section 61.—Auger boring, SW. corner NW. ¼ NW. ¼ sec. 36, T. 34 N., R. 2 E. (Waltham Twp.), Ottawa quadrangle.*

| | Ft. | In. |
|---|---|---|
| Pleistocene system | | |
| Wisconsin stage | | |
| Undifferentiated | | |
| Humus and silt, black to dark gray | 2 | |
| Clay, gray, noncalcareous; limonitic at base | 1 | 6 |
| Tazewell substage | | |
| Farm Ridge drift | | |
| Till, brown, noncalcareous | 1 | |
| Till, brown, calcareous; base not reached | | 6 |

*Geologic section 62.—Auger boring, NW. corner sec. 3, T. 34 N., R. 3 E. (Wallace Twp.), Ottawa quadrangle.*

| | Ft. | In. |
|---|---|---|
| Pleistocene system | | |
| Wisconsin stage | | |
| Undifferentiated | | |
| Humus, silty, black | 1 | |
| Silt, brownish-gray, noncalcareous | 2 | |
| Silt, brownish-gray, limonitic, noncalcareous | 2 | 6 |
| Silt, light gray, limonitic, slightly calcareous | | 6 |
| Cary substage | | |
| Valparaiso drift—Lake Ottawa deposits | | |
| Silt, sandy, light gray, calcareous | 2 | |
| Silt, as above but contains few small pebbles | | 6 |
| Silt, contains beds of medium-grained, well-sorted sand | 2 | |
| Tazewell substage | | |
| Farm Ridge drift | | |
| Till, pebbly, brown, calcareous; base not reached | | 3 |

*Geologic section 63.—Auger boring, SW. corner sec. 11, T. 34 N., R. 3 E. (Wallace Twp.), Ottawa quadrangle.*

| | Ft. | In. |
|---|---|---|
| Pleistocene system | | |
| Wisconsin stage | | |
| Undifferentiated | | |
| Humus, silty, brown | 1 | |
| Silt, dark brown, noncalcareous | 1 | |
| Silt, dark gray, limonitic, noncalcareous | 2 | 6 |
| Silt, light brown, calcareous | 1 | |
| Cary substage | | |
| Valparaiso drift—Lake Ottawa deposits | | |
| Sand, silty, medium-grained, calcareous | | 6 |
| Clay, silty, brown, calcareous, compact | 1 | |
| Clay, pink, calcareous | | 1 |
| Silt, brown, calcareous | 1 | |
| Tazewell substage | | |
| Farm Ridge drift | | |
| Till, pebbly, brown, calcareous; base not reached | 1 | |

*Geologic section 64.—Auger boring, SW. corner sec. 21, T. 34 N., R. 3 E. (Wallace Twp.), Ottawa quadrangle.*

| | Ft. | In. |
|---|---|---|
| Pleistocene system | | |
| Wisconsin stage | | |
| Undifferentiated | | |
| Humus, silty, dark brown | 1 | |
| Silt, dark brownish-gray, limonitic, noncalcareous | | 6 |
| Silt, as above but lighter in color and more limonitic | 1 | |
| Silt, as above but more limonitic | 1 | |
| Clay, mucky, black, slightly calcareous; contains a few pebbles | | 6 |
| Tazewell substage | | |
| Farm Ridge drift | | |
| Till, pebbly, gray, calcareous; base not reached | 3 | |

*Geologic section 65.—South bank of Indian Creek, one mile northwest of Wedron, SW. ¼ SW. ¼ NW. ¼ sec. 4, T. 34 N., R. 4 E. (Dayton Twp.), Ottawa quadrangle.*

| | Ft. | In. |
|---|---|---|
| Pleistocene system | | |
| Wisconsin stage | | |
| Undifferentiated | | |
| Humus, silty, brown | 1 | |
| Silt, brown, noncalcareous; few pebbles at base | 4 | |
| Tazewell substage | | |
| Marseilles drift—Fox River Torrent deposits | | |
| Gravel, brown, weathered | | 6 |
| Gravel, fine, well-sorted, horizontally bedded | 4 | |
| Farm Ridge drift | | |
| Till, clayey, brownish-gray, calcareous; contains slickensided fractures | 6 | |
| Till, bluish-gray, as above | 10 | |
| Bloomington drift | | |
| Gravel, coarse, bouldery | 0–5 | |
| Till, sandy, pink | 20 | |
| Shelbyville drift—Lake Kickapoo deposits | | |
| Clay, bluish-grayish, laminated; sand, coarse-grained; and gravel; interval partly covered | 10 | |
| Illinoian (?) stage | | |
| Till, bluish-gray; interval partly covered; base on St. Peter sandstone | 20–25 | |

*Geologic section 66.—South bank of Crookedleg Creek, NE. ¼ NE. ¼ NE. ¼ sec. 6, T. 34 N., R. 4 E. (Dayton Twp.), Ottawa quadrangle.*

| | Ft. | In. |
|---|---|---|
| Pleistocene system | | |
| Wisconsin stage | | |
| Undifferentiated | | |
| Humus, silty, brown | 1 | |

| | Thickness Ft. | In. |
|---|---|---|
| Silt, brown, noncalcareous | 3 | |
| Tazewell substage | | |
| Farm Ridge drift | | |
| Till, silty, pebbly, light yellowish-gray at top, light gray at base; contains many boulders | 6–7 | |
| Bloomington drift | | |
| Lake Illinois sand, yellowish-brown, fine-grained, in thin horizontal beds | 2–3 | |
| Till, gravelly, pinkish-brown, upper 6 inches laminated light and dark brown; contains lenses of gravel and sand | 6 | |
| Till, very sandy, pinkish-brown; contains many boulders; base concealed | 9 | |

*Geologic section 67.—Auger boring, SW. corner sec. 8, T. 34 N., R. 4 E. (Dayton Twp.), Ottawa quadrangle.*

| | Thickness Ft. | In. |
|---|---|---|
| Pleistocene system | | |
| Wisconsin stage | | |
| Undifferentiated | | |
| Humus, silty black | 1 | |
| Clay, silty, dark brownish-gray, noncalcareous | 2 | |
| Silt, brownish-gray, noncalcareous | | 6 |
| Silt, light yellowish-brown, calcareous | 1 | 6 |
| Tazewell substage | | |
| Farm Ridge drift | | |
| Till, brownish-gray, calcareous; base not reached | | 2 |

*Geologic section 68.—Overburden at quarry of Wedron Silica Co., NW. ¼ NE. ¼ SW. ¼ sec. 9, T. 34 N., R. 4 E. (Dayton Twp.), Ottawa quadrangle.*

| | Thickness Ft. | In. |
|---|---|---|
| Pleistocene system | | |
| Wisconsin stage | | |
| Undifferentiated | | |
| Humus, silty, black | 1 | |
| Silt, brown, noncalcareous | 2 | |
| Tazewell substage | | |
| Marseilles drift—Fox River Torrent deposits | | |
| Gravel, fine to coarse; occurs in shallow channels | 0–2 | |
| Farm Ridge drift | | |
| Till, light yellowish-gray; no pebbles in lower 1 foot | 9–10 | |
| Bloomington drift—Lake Illinois deposits | | |
| Sand, silty, yellow, well-bedded | 1 | |
| Silt, yellow, nonbedded | 2–8 | |
| Bloomington drift | | |
| Till, sandy, pink; top and bottom very irregular | 12–16 | |
| Sand, and fine gravel, cross-bedded | 8–12 | |
| Shelbyville drift—Lake Kickapoo deposits | | |
| Clay, silty, red, calcareous, laminated; contains small lenses of white clay | 0–2 | |
| Clay, reddish-brown, calcareous, nonbedded; contains many fragments of wood, some 6 inches thick | 0–15 | |
| Sangamon stage | | |
| Muck and clay (slope wash?), silty, pebbly, dark greenish-gray to brownish-black, noncalcareous; contains much organic material including wood; present only on slopes of old valley | 0–3 | |
| Peat, brown, only in bottom of old valley | 0–1 | |
| Silt, loess-like, dark gray, calcareous, fossiliferous | | 0–8 |
| Illinoian stage | | |
| Till, (gumbotil ?), clayey, brown, noncalcareous, plastic; contains few pebbles | | 0–6 |
| Till, pebbly, brown, noncalcareous | 0–1 | |
| Till, brown, calcareous | 0–2 | |
| Till, silty and gravelly, yellow, gray, brown, calcareous, faintly stratified; contains large lenses of silty gravel and silt through and on top of till; wood fragments common in dark gray bands | 0–6 | |
| Kansan stage | | |
| Till, sandy, greenish-brown, noncalcareous | 0–3 | |
| Pre-Kansan stage | | |
| Sand and silt, noncalcareous, interbedded; sand is rusty brown, very fine-grained, in 2- to 4-inch beds; silt is light gray, in ¼- to 1-inch beds; beds dip uniformly to northwest, irregularly truncated by overlying deposits, slightly contorted; base on St. Peter sandstone | 0–10 | |

*Geologic section 68A.—Road-cut in east bluff of Fox Valley, NW. ¼ NE. ¼ SE. ¼ sec. 9, T. 34 N., R. 4 E. (Rutland Twp.), Ottawa quadrangle.*

| | Thickness Ft. | In. |
|---|---|---|
| Pleistocene system | | |
| Wisconsin stage | | |
| Humus, dark brown | 1 | |
| Silt, brown, noncalcareous | 2–3 | |
| Tazewell substage | | |
| Marseilles drift | | |
| Gravel, bouldery, silty, brown | 0–2 | |
| Farm Ridge drift | | |
| Till, silty, yellowish-brown, calcareous | 3–4 | |
| Bloomington drift | | |
| Gravel, bouldery | 0–2 | |
| Till, sandy, pink | 3–5 | |
| Sand, yellow, medium-grained, finely cross-bedded; eroded in south part of exposure | 0–4 | |

| | Thickness Ft. | In. |
|---|---|---|
| Illinoian (?) drift | | |
| Till, very sandy and bouldery, yellowish-brown, calcareous; similar to the Illinoian till in geologic section 68 . . . . . . . . | 2–6 | |
| Tertiary (?) systems | | |
| Conglomerate and sandstone, cemented with limonite; base on St. Peter sandstone . . . . . . | 2–3 | |

*Geologic section 69.—Outcrop along stream one and a half miles south of Sulphur Springs, SE. ¼ SW. ¼ NE. ¼ sec. 21, T. 34 N., R. 4 E. (Rutland Twp.), Ottawa quadrangle.*

| | Thickness Ft. | In. |
|---|---|---|
| Pleistocene system | | |
| Wisconsin stage | | |
| Undifferentiated | | |
| Humus, silty . . . . . . | 1 | |
| Silt, dark brown, noncalcareous . . . . . . . . . . | 2 | |
| Tazewell substage | | |
| Marseilles drift | | |
| Gravel, sandy, poorly sorted, 3-inch pebbles common; contains lenses of sand at base . . . . . . . . . . | 2–8 | |
| Bloomington drift | | |
| Till, brownish-gray, calcareous; contains gravel lenses . . . . . . . . . | 6–12 | |
| Sand, medium-grained, well-sorted, cross-bedded; contains few pebbles; interval partly covered . . . . . | 15–25 | |
| Shelbyville drift—Lake Kickapoo deposits | | |
| Clay, red, calcareous, laminated . . . . . . . . . | 1 | |
| Clay, dark reddish-brown, calcareous, nonbedded . | 8 | |
| Shelbyville drift | | |
| Till, brownish-gray, calcareous . . . . . . . . . . | 0–10 | |
| Sangamon stage | | |
| Silt, peaty, very dark gray to black at top, medium gray at base, noncalcareous, soft, light weight . . | 2 | |
| Sand, gray, medium-grained, well-sorted, limonitic, replaced locally by silt, sandy, gray, noncalcareous; base concealed | 2–4 | |

*Geologic section 70.—Gravel pit, SE. ¼ SE. ¼ NE. ¼ sec. 31, T. 34 N., R. 4 E. (Dayton Twp.), Ottawa quadrangle.*

| | Thickness Ft. | In. |
|---|---|---|
| Pleistocene system | | |
| Wisconsin stage | | |
| Undifferentiated | | |
| Humus, silty . . . . . . | 1 | |
| Silt, brown, noncalcareous . | 4 | |
| Cary substage | | |
| Valparaiso drift—Kankakee Torrent deposits | | |
| Sand, pebbly, silty, brown, horizontal bedding; boulders along base . . . | 1 | 6 |
| Tazewell substage | | |
| Farm Ridge drift—Lake Illinois delta | | |
| Gravel, sandy, bouldery, fine and coarse, interbedded; contains gray till balls; many angular pebbles and cobbles; beds dip uniformly 10 degrees west; base concealed; (Samples ML-181, W-5) . . . . . | 20 | |

*Geologic section 71.—Auger boring, SE. corner sec. 19, T. 33 N., R. 4 E. (Fall River Twp.), Ottawa quadrangle.*

| | Thickness Ft. | In. |
|---|---|---|
| Pleistocene system | | |
| Wisconsin stage | | |
| Undifferentiated | | |
| Humus, silty . . . . . . | 1 | 6 |
| Silt, brown, noncalcareous . | 2 | |
| Cary substage | | |
| Valparaiso drift—Lake Ottawa deposits | | |
| Silt, gray, calcareous; with thin bed of sand and gravel; base not reached . | 5 | |

*Geologic section 72.—Gravel pit, SE. ¼ SW. ¼ SE. ¼ sec. 15, T. 33 N., R. 3 E. (South Ottawa Twp.), Ottawa quadrangle.*

| | Thickness Ft. | In. |
|---|---|---|
| Pleistocene system | | |
| Wisconsin stage | | |
| Undifferentiated | | |
| Humus, silty . . . . . . | 1 | |
| Silt, brown, noncalcareous . | 2 | |
| Tazewell substage | | |
| Farm Ridge drift—Lake Illinois delta | | |
| Gravel, fine, cross-bedded . | 10 | |
| Silt, brownish-gray, calcareous . . . . . . . . . . | 1–2 | |
| Gravel, fine, angular, poorly sorted; beds dip steeply to west; base concealed; (Samples ML-130, ML-194) . . . . . . . . | 15 | |

*Geologic section 73.—Auger boring, SE. corner NE. ¼ SE. ¼ SW. ¼ sec. 23, T. 33 N., R. 3 E. (South Ottawa Twp.), Ottawa quadrangle.*

| | Thickness Ft. | In. |
|---|---|---|
| Pleistocene system | | |
| Wisconsin stage | | |
| Undifferentiated | | |
| Humus, silty . . . . . . | | 6 |
| Silt, gray, noncalcareous . | 2 | |
| Cary substage | | |
| Valparaiso drift—Lake Ottawa deposits | | |
| Sand, brown . . . . . . | | 6 |
| Silt, pebbly, brown, noncalcareous . . . . . . . . | 1 | 6 |
| Sand, brown, coarse-grained | 4 | 6 |
| Gravel, base not reached . | | 6 |

*Geologic section 74.—Auger boring, SE. corner sec. 24, T. 33 N., R. 3 E. (South Ottawa Twp.), Ottawa quadrangle.*

| | Thickness Ft. | In. |
|---|---|---|
| Pleistocene system | | |
| Wisconsin stage | | |
| Undifferentiated | | |
| Humus, silty, brown | 1 | 6 |
| Silt, brown, noncalcareous | 2 | |
| Cary substage | | |
| Valparaiso drift—Lake Ottawa deposits | | |
| Silt, gray, calcareous, soft, nonbedded; base not reached | 8 | 6 |

*Geologic section 75.—Gravel pit, NW. ¼ SW. ¼ SE. ¼ sec. 10, T. 33 N., R. 2 E. (Utica Twp.), Ottawa quadrangle.*

| | Ft. | In. |
|---|---|---|
| Pleistocene system | | |
| Wisconsin stage | | |
| Undifferentiated | | |
| Humus, silty, black | | 8 |
| Silt, brown, noncalcareous | 2 | |
| Tazewell substage | | |
| Farm Ridge drift—Lake Illinois delta | | |
| Gravel, clayey, brown, weathered | 1 | 6 |
| Gravel, sandy, fine; contains many large boulders and gray till balls; beds dip steeply to west; reported to be 27 feet thick; base concealed; (Sample W-18) | 10 | |

*Geologic section 76.—Auger boring at crest of hill, NW. ¼ SE. ¼ SW. ¼ sec. 35, T. 33 N., R. 2 E. (Deer Park Twp.), Ottawa quadrangle.*

| | Ft. | In. |
|---|---|---|
| Pleistocene system | | |
| Wisconsin stage | | |
| Undifferentiated | | |
| Humus, silty, brown | 1 | |
| Silt, dark brown, noncalcareous | 3 | |
| Silt, light brownish-gray, calcareous | 1 | |
| Sand and silt interbedded, calcareous | | 6 |
| Tazewell substage | | |
| Farm Ridge drift | | |
| Till, yellowish-gray; base not reached | | 2 |

*Geologic section 77.—Railroad cut, SW. ¼ SW. ¼ NE ¼ sec. 1, T. 32 N., R. 3 E. (Farm Ridge Twp.), Ottawa quadrangle.*

| | Ft. | In. |
|---|---|---|
| Pleistocene system | | |
| Wisconsin stage | | |
| Undifferentiated | | |
| Humus, silty | 1 | |
| Silt, sandy, yellow | 5 | |
| Tazewell substage | | |
| Farm Ridge drift | | |
| Till, gravelly, faintly bedded | 1 | |
| Sand and fine gravel, interbedded with gray till in 1- to 4-inch bands; base concealed | 2 | |

*Geologic section 78.—Northeast bank of Covel Creek, NE. ¼ SW. ¼ NE. ¼ sec. 6, T. 32 N., R. 4 E. (Grand Rapids Twp.), Ottawa quadrangle.*

| | Thickness Ft. | In. |
|---|---|---|
| Pleistocene system | | |
| Wisconsin stage | | |
| Undifferentiated | | |
| Humus, silty, brown | 1 | |
| Silt, brown, noncalcareous | 3 | |
| Tazewell substage | | |
| Marseilles drift | | |
| Gravel, bouldery, yellow, cross-bedded | 1–5 | |
| Farm Ridge drift | | |
| Till, clayey, gray, boulders rare | 5–10 | |
| Bloomington drift—Lake Illinois deposits | | |
| Silt, light gray, laminated | | 2 |
| Sand, coarse | | 1–3 |
| Bloomington drift | | |
| Till, pink; base concealed | 10–15 | |

*Geologic section 79.—Auger boring at north end of channel across the Farm Ridge moraine, SE. ¼ SW. ¼ sec. 22, T. 32 N., R. 4 E. (Grand Rapids Twp.), Streator quadrangle.*

| | Ft. | In. |
|---|---|---|
| Pleistocene system | | |
| Wisconsin stage | | |
| Undifferentiated | | |
| Humus and silt, black at top, dark brown at base | 2 | |
| Clay, dark gray at top, light gray at base, noncalcareous; contains a few small pebbles in lower part | 1 | 6 |
| Cary substage | | |
| Valparaiso drift—Lake Ottawa deposits | | |
| Gravel and sand, brown, poorly sorted, noncalcareous | | 6 |
| Tazewell substage | | |
| Farm Ridge drift | | |
| Till, light gray, calcareous; base not reached | 1 | 6 |

*Geologic section 80.—Auger boring, SW. corner sec. 34, T. 32 N., R. 4 E. (Grand Rapids Twp.), Streator quadrangle.*

| | Ft. | In. |
|---|---|---|
| Pleistocene system | | |
| Wisconsin stage | | |
| Undifferentiated | | |
| Humus, silty, black | 1 | 6 |
| Silt, brown, noncalcareous | | 6 |
| Silt, light gray to brown, noncalcareous; contains a few small pebbles | 2 | |
| Cary substage | | |
| Valparaiso drift—Lake Pontiac deposits | | |
| Sand, light gray to brown, coarse-grained, slightly calcareous | 1 | |

| | Thickness Ft. | In. |
|---|---|---|
| Tazewell substage | | |
| Cropsey drift | | |
| Till, pebbly, light bluish-gray, slightly calcareous; base not reached . . . . | | 6 |

*Geologic section 81.—South bank of creek, SW. ¼ NE. ¼ sec. 35, T. 32 N., R. 2 E. (Vermilion Twp.), Streator quadrangle.*

| | Ft. | In. |
|---|---|---|
| Pleistocene system | | |
| Wisconsin stage | | |
| Tazewell substage | | |
| Cropsey drift | | |
| Till, silty, greenish-gray, calcareous, crumbly; contains few pebbles; grades down to . . . . . . . | 1 | 8 |
| Till as above but more calcareous and not crumbly | | 6 |
| Till, clayey, brown and gray, calcareous; contains few small pebbles . . . . . | 5 | |
| Bloomington drift—Lake Illinois deposits | | |
| Silt, olive drab, calcareous . | 1 | 3 |
| Clay, brown, and silt, tan; bedding distorted . . . | | 6 |
| Silt, gray, calcareous, laminated . . . . . . . . | | 4 |
| Silt, tan, calcareous . . . | | 7 |
| Clay . . . . . . . . . . . | | 1 |
| Sand, light to dark yellow, medium- to coarse-grained, calcareous; interbedded with silt, light tan, calcareous . . . . | 2 | 6 |
| Gravel, pebbles up to 3 inches in diameter . . . | | 4 |
| Bloomington drift | | |
| Till, pink, calcareous . . . | 1 | 11 |
| Sand, coarse to medium, slightly calcareous; base concealed . . . . . . . | 3 | |

*Geologic section 82.—Auger boring, NE. corner sec. 11, T. 31 N., R. 3 E. (Bruce Twp.), Streator quadrangle.*

| | Ft. | In. |
|---|---|---|
| Pleistocene system | | |
| Wisconsin stage | | |
| Undifferentiated | | |
| Humus, silty, black . . . | 1 | |
| Silt, brown, noncalcareous . | 1 | 6 |
| Silt, light gray, limonitic, noncalcareous; contains a few small pebbles . . . | 1 | 6 |
| Cary substage | | |
| Valparaiso drift—Lake Pontiac deposits | | |
| Sand, light gray, mottled with limonite, noncalcareous . . . . . . . . . | 1 | 3 |
| Tazewell substage | | |
| Cropsey drift | | |
| Till, dark gray, calcareous; base not reached . . . . | | 3 |

*Geologic section 83.—East bank of creek, one mile east of Wilsman, NE. ¼ SE. ¼ sec. 7, T. 31 N., R. 3 E. (Eagle Twp.), Streator quadrangle.*

| | Thickness Ft. | In. |
|---|---|---|
| Pleistocene system | | |
| Wisconsin stage | | |
| Tazewell substage | | |
| Cropsey drift | | |
| Till, silty, greenish-gray, calcareous . . . . . . | 4 | |
| Sand, brown, gravel at base | | 2 |
| Bloomington drift | | |
| Till, silty, pink, slightly calcareous at top, more calcareous at base . . . . | 7 | |
| Sand, brown, coarse-grained; base concealed . | 1 | |

*Geologic section 84.—Composite section along creek, SW. ¼ sec. 8, T. 31 N., R. 3 E. (Eagle Twp.), Streator quadrangle.*

| | Ft. | In. |
|---|---|---|
| Pleistocene system | | |
| Wisconsin stage | | |
| Tazewell substage | | |
| Cropsey drift | | |
| Till, brown, calcareous, grades down to . . . . | 3 | |
| Till, silty, greenish-gray, calcareous . . . . . . . | 7 | |
| Bloomington (?) drift | | |
| Sand, brown, calcareous; locally stained with limonite; gravelly toward top; local gravel zone 13 feet thick . . . . . . . . . . | 18 | |
| Till, clayey, blue, calcareous; base concealed . . | 6 | |

*Geologic section 85.—Road-cut in west bluff of Vermilion Valley, one-half mile north of Kangley, SW. ¼ NW. ¼ sec. 15, T. 31 N., R. 3 E. (Eagle Twp.), Streator quadrangle.*

| | Ft. | In. |
|---|---|---|
| Pleistocene system | | |
| Wisconsin stage | | |
| Cary substage | | |
| Valparaiso drift—Lake Pontiac deposits | | |
| Silt, gray, noncalcareous . | | 8 |
| Silt, brown, noncalcareous . | | 10 |
| Gravel, brown to black, weathered . . . . . . | | 4 |
| Tazewell substage | | |
| Cropsey drift | | |
| Till, sandy to silty, light brown, with many pebbles up to 1 inch in diameter; upper 3 inches leached; contains lenses of sand at top . . . . . . | 2 | 2 |
| Sand, yellow, poorly sorted, alternate layers of fine- and coarse-grained, slightly calcareous; contains a few small pebbles; cross-bedded in all directions . . . . . . . . . | | 6 |
| Till, silty, light brown, calcareous . . . . . . . . | | ½ |
| Gravel, fine . . . . . . . | | 1–2 |

| | Thickness Ft. | In. |
|---|---|---|
| Till, silty, light brown, calcareous | 9 | 10 |
| Bloomington drift | | |
| Till, pink | 6 | |
| Sand, coarse-grained | 5 | |
| Shelbyville drift | | |
| Silt, yellow to tan; base concealed | 3 | |

*Geologic section 86.—South bank of Egg Bag Creek, SE. ¼ SW. ¼ NW. ¼ sec. 27, T. 31 N., R. 3 E. (Eagle Twp.), Streator quadrangle.*

| | Ft. | In. |
|---|---|---|
| Pleistocene system | | |
| Wisconsin stage | | |
| Undifferentiated | | |
| Humus and silt, light to dark gray | 1 | |
| Silt, brown | 1 | 5 |
| Silt, light buff, noncalcareous, few small pebbles | 1 | 3 |
| Cary substage | | |
| Valparaiso drift—Lake Pontiac deposits (?) | | |
| Gravel, clayey, silty, fine, slightly calcareous; contains large pebbles at base | | 10 |
| Tazewell substage | | |
| Cropsey drift—Lake Ancona deposits (?) | | |
| Clay, gray, slightly calcareous; contains small pebbles | | 2 |
| Sand, brown, coarse-grained, slightly calcareous | | 6 |
| Silt, greenish-gray, slightly calcareous | | 5 |
| Sand, brown, slightly calcareous | | 4–5 |
| Clay, silty, gray to yellow, calcareous | | 5 |
| Clay, gray, calcareous; contains a few pebbles | | 2–4 |
| Sand, brown, coarse, calcareous; contains small pebbles | | 0–2 |
| Sand, light yellow, fine-grained, calcareous | | 1–2 |
| Sand, dark brown, coarse-grained, calcareous; contains many pebbles | | 2 |
| Sand, light yellow, fine-grained, calcareous, laminated | | 4–5 |
| Gravel and coarse sand | | 3 |
| Clay, gritty, greenish-yellow, very calcareous | | 8 |
| Bloomington drift | | |
| Till, pink, calcareous | | 5 |
| Silt, gravelly, yellowish-brown | | 6 |
| Till, silty, pink | | 8 |
| Till, clayey, greenish-gray, calcareous; contains few pebbles; base concealed | 1 | |

*Geologic section 87.—Auger boring, NE. corner sec. 32, T. 31 N., R. 3 E. (Eagle Twp.), Streator quadrangle.*

| | Thickness Ft. | In. |
|---|---|---|
| Pleistocene system | | |
| Wisconsin stage | | |
| Undifferentiated | | |
| Humus, silty | 1 | |
| Silt, sandy, gray to yellow, noncalcareous | | 6 |
| Silt, sandy, yellow, noncalcareous | | 6 |
| Silt, sandy, yellow to gray, calcareous; base on gravel or till | 2 | 6 |

*Geologic section 88.—Auger boring, NW. corner sec. 5, T. 31 N., R. 4 E. (Otter Creek Twp.), Streator quadrangle.*

| | Ft. | In. |
|---|---|---|
| Pleistocene system | | |
| Wisconsin stage | | |
| Undifferentiated | | |
| Humus, silty, black | 1 | 6 |
| Silt, light gray to light brown, slightly calcareous | 1 | |
| Silt, light gray to brown, slightly calcareous | | 6 |
| Cary substage | | |
| Valparaiso drift—Lake Pontiac deposits | | |
| Silt, yellow to yellowish-gray, calcareous; contains fine-grained sand and a few small pebbles | | 6 |
| Silt, light gray, limonitic, calcareous | | 6 |
| Silt and fine-grained sand, light gray to light yellow, calcareous; contains a few small pebbles | 1 | 6 |
| Clay, silty, pebbly, calcareous, (reworked till?) | 2 | |
| Tazewell substage | | |
| Cropsey drift | | |
| Till, light bluish-gray to brown, calcareous; base not reached | | 6 |

*Geologic section 89.—Auger boring, NW. corner sec. 16, T. 31 N., R. 4 E. (Otter Creek Twp.), Streator quadrangle.*

| | Ft. | In. |
|---|---|---|
| Pleistocene system | | |
| Wisconsin stage | | |
| Undifferentiated | | |
| Humus, silty, black | 1 | 6 |
| Silt, clayey, brown, noncalcareous | | 6 |
| Silt, yellow to light brown, noncalcareous | 1 | |
| Tazewell substage | | |
| Chatsworth drift | | |
| Till, light bluish-gray to brown, calcareous; base not reached | 1 | |

*Geologic section 90.—Stream bank 50 feet south of bridge, NW. ¼ NE. ¼ NE. ¼ sec. 21, T. 31 N., R. 4 E. (Otter Creek Twp.), Streator quadrangle.*

| | Thickness Ft. | In. |
|---|---|---|
| Pleistocene system | | |
| Wisconsin stage | | |
| Undifferentiated | | |
| Humus and silt, loess-like, gray to dark gray, noncalcareous | | 10 |
| Silt, brown, noncalcareous; contains a few small pebbles | 2 | 2 |
| Tazewell substage | | |
| Chatsworth drift | | |
| Gravel, yellow to brown, poorly sorted; contains cobbles up to 4 inches in diameter, layers of sand and a few till balls | 4 | 4 |
| Cropsey drift | | |
| Till, dark gray, calcareous; base concealed | 1 | 6 |

*Geologic section 91.—Auger boring, SW. corner sec. 32, T. 31 N., R. 4 E. (Otter Creek Twp.), Streator quadrangle.*

| | Thickness Ft. | In. |
|---|---|---|
| Pleistocene system | | |
| Wisconsin stage | | |
| Undifferentiated | | |
| Humus, silty, black | 1 | 6 |
| Silt, clayey, brown, noncalcareous | 1 | |
| Silt, tan to yellow, noncalcareous | 1 | 6 |
| Cary substage | | |
| Valparaiso drift—Lake Pontiac deposits | | |
| Sand, yellow, fine-grained, calcareous | 1 | |
| Silt, yellow, calcareous | 2 | |
| Tazewell substage | | |
| Cropsey drift | | |
| Till, greenish-brown, calcareous; contains few pebbles | 3 | |
| Till, gray, calcareous; contains few pebbles; base not reached | 4 | |

*Geologic section 92.—Composite section of gravel pit and outcrop on west side Vermilion River, NW. ¼ NE. ¼ SW. ¼ sec. 19, T. 30 N., R. 4 E. (Newtown Twp.), Streator quadrangle.*

| | Thickness Ft. | In. |
|---|---|---|
| Pleistocene system | | |
| Wisconsin stage | | |
| Cary substage | | |
| Valparaiso drift—Lake Pontiac deposits | | |
| Gravel, well sorted | | 8 |
| Silt, gray, laminated; grades down to | | 6 |
| Silt, yellowish-brown; grades down to | | 8 |
| Gravel, silty, reddish-brown, poorly sorted, noncalcareous; more silt and sand in lower 2 feet | 3 | 3 |
| Tazewell substage | | |
| Cropsey drift | | |
| Till, silty, grayish-green, calcareous | | 6 |
| Cropsey drift—Lake Illinois deposits | | |
| Gravel, very silty, yellow, noncalcareous | | 0–6 |
| Gravel, brown, poorly sorted; upper part sandy | 1 | 3 |
| Sand, brown, coarse- to fine-grained; 6-inch gravelly layer with coal fragments at base | 5 | 5 |
| Bloomington drift—Lake Illinois deposits | | |
| Silt, yellow to light brown, laminated | | 0–12 |
| Gravel, poorly sorted, bouldery; contains pink till balls up to 2 feet in diameter; locally has deltal structure; upper surface irregular with relief of at least 3 feet; lower surface also irregular | 8–15 | |
| Bloomington drift | | |
| Till, clayey, pink, calcareous | 4 | |
| Shelbyville drift | | |
| Till, light green, mottled blue, upper part slightly leached; base on bedrock | 3 | 4 |

*Geologic section 93.—North bank of Mud Creek, NE. ¼ NW. ¼ SE. ¼ sec. 33, T. 30 N., R. 4 E. (Newtown Twp.), Streator quadrangle.*

| | Thickness Ft. | In. |
|---|---|---|
| Pleistocene system | | |
| Wisconsin stage | | |
| Undifferentiated | | |
| Humus, silty, gray | 1 | |
| Silt, chocolate-brown | 1 | 6 |
| Cary substage | | |
| Valparaiso drift—Lake Pontiac deposits | | |
| Clay, dark gray | 1 | |
| Silt, yellow | 5 | |
| Tazewell substage | | |
| Cropsey drift | | |
| Till, gray, greenish at top, dark gray and clayey at base; base concealed | 12 | |

*Geologic section 94.—Auger boring, SW. corner NW. ¼ sec. 1, T. 30 N., R. 3 E. (Reading Twp.), Streator quadrangle.*

| | Thickness Ft. | In. |
|---|---|---|
| Pleistocene system | | |
| Wisconsin stage | | |
| Undifferentiated | | |
| Humus, silty, black | 1 | 6 |
| Silt, light brown, slightly calcareous | 1 | |
| Silt, light tan to yellow, | 1 | |
| Slightly calcareous | 1 | |
| Cary substage | | |
| Valparaiso drift—Lake Pontiac deposits | | |
| Gravel, silty, fine, slightly calcareous | 1 | |

| | Thickness Ft. | In. |
|---|---|---|
| Sand, yellowish-brown, coarse-grained with a few pebbles, calcareous . . . | 3 | |
| Sand, gray, coarse-grained, pebbly . . . . . . . . | 2 | 3 |
| Tazewell substage | | |
| Cropsey drift | | |
| Till, greenish-gray, calcareous; base not reached . . | | 9 |

*Geologic section 95.—Auger boring at Koontz school, SE. corner sec. 6, T. 30 N., R. 3 E. (Reading Twp.), Streator quadrangle.*

| | Ft. | In. |
|---|---|---|
| Pleistocene system | | |
| Wisconsin stage | | |
| Undifferentiated | | |
| Humus and silt, black . . | 1 | 6 |
| Silt, gray to yellow, sandy, calcareous in lower part . | 2 | 6 |
| Tazewell substage | | |
| Cropsey drift | | |
| Till, sandy, gray, calcareous; contains numerous pebbles; base not reached | 2 | |

*Geologic section 96.—North bank of Moon Creek, south of road, SE. ¼ SE. ¼ SE. ¼ sec. 10, T. 30 N., R. 3 E. (Reading Twp.), Streator quadrangle.*

| | Ft. | In. |
|---|---|---|
| Pleistocene system | | |
| Wisconsin stage | | |
| Undifferentiated | | |
| Humus, silty . . . . . . | | 4 |
| Silt, brown, noncalcareous . | 2 | |
| Cary substage | | |
| Valparaiso drift — Lake Pontiac deposits | | |
| Silt, sandy, yellow, noncalcareous, laminated . . . | 1 | 6 |
| Silt, gravelly, yellow, noncalcareous . . . . . . | | 6 |
| Tazewell substage | | |
| Cropsey drift | | |
| Till, silty, pebbly, brown . | | 4 |
| Covered . . . . . . . . . | 7 | |
| Till, silty, brownish-gray, calcareous . . . . . . | 1 | |
| Silt, light brown, calcareous | | 8 |
| Sand, brown, medium- to coarse-grained, calcareous; base concealed . . . | 1 | |

*Geologic section 97.—Auger boring west side of Mud Lane School, SW. corner NW. ¼ sec. 16, T. 30 N., R. 3 E. (Reading Twp.), Streator quadrangle.*

| | Thickness Ft. | In. |
|---|---|---|
| Pleistocene system | | |
| Wisconsin stage | | |
| Undifferentiated | | |
| Humus, silty, black . . . | 1 | |
| Silt, brown, slightly calcareous . . . . . . . . . . | 1 | 6 |
| Silt, light gray to brown, calcareous . . . . . . | | 6 |
| Cary substage | | |
| Valparaiso drift—Lake Pontiac deposits | | |
| Sand, light yellow, brown, and gray, fine-grained, calcareous . . . . . . | 4 | |
| Gravel, sandy, brown, calcareous . . . . . . . . | | 6 |
| Gravel, gray to brown, fine-grained, calcareous . . . | 1 | 6 |
| Sand, pebbly, brown, calcareous . . . . . . . . | | 6 |
| Tazewell substage | | |
| Cropsey drift | | |
| Till, silty, greenish-gray, calcareous; base not reached | | 6 |

*Geologic section 98.—Auger boring, SE. corner sec. 21, T. 30 N., R. 3 E. (Reading Twp.), Streator quadrangle.*

| | Ft. | In. |
|---|---|---|
| Pleistocene system | | |
| Wisconsin stage | | |
| Undifferentiated | | |
| Humus and silt, black . . | 1 | 6 |
| Silt, dark gray, noncalcareous . . . . . . . . . . | | 6 |
| Silt, light gray, slightly calcareous . . . . . . . . | | 6 |
| Silt, light gray to light tan, slightly calcareous . . . | 1 | |
| Cary substage | | |
| Valparaiso drift — Lake Pontiac deposits | | |
| Sand, light tan to light yellow, mottled, gray, fine-grained, calcareous . . . | 2 | 6 |
| Sand, light gray, mottled yellow, fine-grained, calcareous . . . . . . . . | 1 | |
| Sand, light tan to brown, calcareous; contains a few small pebbles . . . . . | 2 | 3 |
| Gravel, sandy, fine . . . . | | 6 |
| Sand, brown, medium-grained calcareous . . . | | 3 |
| Sand, silty, grayish-brown, calcareous . . . . . . | | 6 |
| Gravel, sandy, brown, poorly sorted, calcareous . . . | 1 | |
| Gravel, silty, grayish-brown, calcareous; contains black shale pebbles . . . . . | | 6 |
| Silt, bluish-gray, calcareous; base not reached . . . . | 2 | |

*Geologic section 99.—Auger boring south of Buffalo School, NW. corner sec. 36, T. 30 N., R. 2 E. (Osage Twp.), Streator quadrangle.*

| | Ft. | In. |
|---|---|---|
| Pleistocene system | | |
| Wisconsin stage | | |
| Undifferentiated | | |
| Humus, silty, black . . . | | 6 |
| Silt, light gray, noncalcareous . . . . . . . . . . | 1 | |
| Silt, light gray to tan, noncalcareous . . . . . . | 1 | |
| Silt, light gray to tan, calcareous; contains calcium carbonate concretions . | 1 | 6 |
| Tazewell substage | | |
| Cropsey drift—Lake Ancona deposits | | |
| Sand, pebbly, light tan, mottled gray, coarse-grained, calcareous . . . | 1 | |

| | Thickness Ft. | In. |
|---|---|---|
| Sand, light tan to yellow, fine-grained, calcareous; contains a few pebbles | 2 | 6 |
| Cropsey drift | | |
| Till, silty, pinkish-gray, calcareous | 1 | |
| Till, bluish-gray, calcareous; base not reached | 1 | 6 |

*Geologic section 100.—Auger boring, NW. corner sec. 5, T. 29 N., R. 3 E. (Long Point Twp.), Streator quadrangle.*

| | Ft. | In. |
|---|---|---|
| Pleistocene system | | |
| Wisconsin stage | | |
| Undifferentiated | | |
| Humus, silty, black | 1 | |
| Silt, light gray, noncalcareous | 1 | |
| Silt, light gray to light yellow, calcareous | 1 | 6 |
| Cary substage | | |
| Valparaiso drift — Lake Pontiac deposits | | |
| Sand, silty, light gray to yellow, fine-grained, calcareous | | 6 |
| Sand, brown, fine-grained, calcareous; contains a few small pebbles in lower half | 1 | |
| Gravel, brown, fine, calcareous; contains much sand | | 6 |
| Tazewell substage | | |
| Cropsey drift | | |
| Till, greenish-gray with brownish tinge, calcareous | 3 | 6 |
| Till, dark gray, calcareous; base not reached | 1 | 6 |

*Geologic section 101.—North bank of Long Point Creek, south of house, SE. ¼ SE. ¼ SE. ¼ sec. 3, T. 29 N., R. 3 E. (Long Point Twp.), Streator quadrangle.*

| | Ft. | In. |
|---|---|---|
| Peistocene system | | |
| Wisconsin stage | | |
| Undifferentiated | | |
| Humus, silty, black | 1 | 3 |
| Silt, brown, noncalcareous | 1 | 3 |
| Cary substage | | |
| Valparaiso drift — Lake Pontiac deposits | | |
| Gravel, pebbles up to 1 inch in diameter, rounded to subangular; irregular contact on | | 3–7 |
| Tazewell substage | | |
| Cropsey drift | | |
| Till, clayey, greenish-gray, slightly calcareous; contains numerous small pebbles | | 7–12 |
| Cropsey drift—Lake Illinois deposits | | |
| Sand, brown, noncalcareous, partly laminated; upper 3 inches mixed with pebbles and clay | | 8 |
| Gravel, very sandy | | 3 |
| Bloomington (?) drift—Lake Illinois deposits | | |
| Sand | | 4 |
| Clay, bluish-gray, soft | | 0–¾ |
| Sand | | 1 |
| Clay, bluish-gray, soft | | ½–1 |
| Bloomington (?) drift | | |
| Till, silty, bluish-gray, calcareous; base concealed | 6 | |

*Geologic section 102.—North side State Highway 23, at east end of bridge over Short Point Creek, SE. ¼ SE. ¼ sec. 8, T. 29 N., R. 4 E. (Amity Twp.), about one mile south of Streator quadrangle.*

| | Ft. | In. |
|---|---|---|
| Pleistocene system | | |
| Wisconsin stage | | |
| Undifferentiated | | |
| Humus, silty | | 6 |
| Silt, brown | | 8 |
| Cary substage | | |
| Valparaiso drift — Lake Pontiac deposits | | |
| Gravel, fine, weathered, clayey, brown, noncalcareous | 1 | 3 |
| Gravel, sandy, yellowish-brown, poorly sorted, noncalcareous | 2 | 2 |
| Tazewell substage | | |
| Cropsey drift | | |
| Till, pebbly, greenish-gray, mottled brown, slightly calcareous in upper 2 feet, lower part highly calcareous | 9 | 7 |
| Bloomington (?) drift | | |
| Clay, gray, calcareous; streaked with limonite along joints | | 4 |
| Silt, yellow to brown, calcareous | | 3 |
| Sand, silty, brown, medium-grained, calcareous, laminated; contains clay lenses | 3 | 7 |
| Gravel, sand, and clay interbedded, gray to buff; contains coal fragments | | 8 |
| Clay, slightly silty, yellowish-gray, calcareous | | 5 |
| Sand, yellowish-brown, medium-grained, calcareous | 2–3 | |
| Illinoian (?) stage | | |
| Till, very sandy, olive drab to brown diffusion banding, noncalcareous, hard; upper surface irregular with depressions filled with sand lenses, 0–2 inches thick; grades downward to | | 0–7 |
| Till, blue with green, purple, and violet tinges, slightly calcareous | 2 | |
| (Continued as auger boring) | | |
| Till, as above | 2 | |
| Sand, coarse; base on Pennsylvanian shale | 2 | 6 |

# APPENDIX B
# RECORDS OF BORINGS AND MINE SHAFTS

By
H. B. Willman

The descriptions of the materials penetrated in the borings and shafts are as given in the records provided by the persons listed as authorities. All interpretations of nonstandard terms are shown in parentheses.

The correlations are by the author. Unit numbers are not given for those strata lower or higher than those cropping out in the Marseilles-Ottawa-Streator quadrangles. The absence of certain unit numbers may indicate either that these units are absent or that they are included with adjacent beds.

All elevations are estimated from the topographic maps, except where noted.

The locations of all the diamond-drill borings and mine shafts for which records are available are shown and numbered on plate 6. Where the borings are closely spaced and record similar sequences, only a few typical records have been selected for publication. Records of the other borings may be examined at the State Geological Survey, Urbana, Illinois.

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*1.—Chicago, Wilmington and Vermilion Coal Company boring,*[1] *NE. ¼ sec. 2, T. 31 N., R. 3 E. (Bruce Twp.), LaSalle County, Streator quadrangle.*

Elevation 650 feet

| Unit No. | | Thickness Ft. In. | Depth Ft. In. |
|---|---|---|---|
| | Pleistocene system | | |
| | "Surface" material | 74 | 74 |
| | Pennsylvanian system | | |
| | St. David cyclothem | | |
| 40 | Canton shale | | |
| | Clay-shale, blue, soft | 6 | 80 |
| | Shale, sandy, dark | 23 | 103 |
| | Shale, black, hard | 3 | 106 |
| | Shale, sandy, light | 19 | 125 |
| 39 | "Slate" (shale), black | 4 | 129 |
| 36-38 | Shale, sandy, light | 3 | 132 |
| | Summum cyclothem | | |
| 28-29 | "Fireclay" and limestone | 4 | 136 |
| 27 | Shale, light | 2 | 138 |
| 26 | Summum (No. 4) coal with shale partings | 1— 3 | 139— 3 |
| 25 | "Fireclay" | 10— 9 | 150 |
| 17 | Pleasantview sandstone | | |
| | Shale, sandy | 2 | 152 |
| | Limestone (sandstone?), gray | 4 | 156 |
| | Lowell cyclothem? | | |
| 11? | "Slate" (shale), black | 2 | 158 |
| | Liverpool cyclothem | | |
| 5 | Francis Creek shale | 23 | 181 |
| 4 | LaSalle (No. 2) coal | 2 | 183 |
| 3 | "Fireclay" | 4 | 187 |
| | Shale, sandy | 26 | 213 |
| | Undifferentiated | | |
| | Sandstone | 15 | 228 |

[1]Authority DuQuoin Diamond Drill Co.

*3.—Acme Coal Co. boring No. 3,*[1] *French farm, NW. ¼ NW. ¼ NW. ¼ sec. 3, T. 31N., R. 3 E. (Bruce Twp.), LaSalle County, Streator quadrangle.*

Elevation 650 feet

| Unit No. | | Thickness Ft. In. | Depth Ft. In. |
|---|---|---|---|
| | Pleistocene system | | |
| | Soil | 3 | 3 |
| | Clay, yellow | 7 | 10 |
| | "Hardpan" (till) | 17— 3 | 27— 3 |
| | Sand | 2 | 29— 3 |
| | "Hardpan" (till) | 27 | 56— 3 |
| | Clay and sand | 3— 3 | 59— 6 |
| | Pennsylvanian system | | |
| | Brereton cyclothem | | |
| 56 | "Rock," hard, (limestone?) | 2 | 61— 6 |
| 55 | Shale, white | 24 | 85— 6 |
| 54 | Shale, black | 10 | 95— 6 |
| 51 | Coal mixed with "sulphur" (pyrite) | 5— 5 | 100—11 |
| 50 | "Fireclay" | 7 | 101— 6 |

[1]Authority Thomas Fairbairne

*5.—Acme Coal Co. boring No. 1,*[1] *French farm, NE. corner SW. ¼ sec. 3, T. 31 N., R. 3 E. (Bruce Twp.), LaSalle County, Streator quadrangle.*

Elevation 647 feet

| Unit No. | | Thickness Ft. In. | Depth Ft. In. |
|---|---|---|---|
| | Pleistocene system | | |
| | Soil, black | 2 | 2 |
| | Clay, yellow | 6 | 8 |
| | "Hardpan" (till) | 21 | 29 |
| | Sand, yellow | 4 | 33 |
| | "Hardpan" (till) | 23 | 56 |
| | Clay and boulders (till?) | 3 | 59 |
| | Sand, coarse, white | 1 | 60 |

| Unit No. | | Thickness Ft. | Thickness In. | Depth Ft. | Depth In. |
|---|---|---|---|---|---|
| | Pennsylvanian system | | | | |
| | Brereton cyclothem | | | | |
| 56 | "Rock," hard, (limestone?), white | 1 | 8 | 61 | 8 |
| 55 | Shale, soft | 1 | 3 | 62 | 11 |
| 54 | Shale, black, hard | 12 | 6 | 75 | 5 |
| 52 | Shale, light, hard | 5 | 4 | 80 | 9 |
| " | Shale, light, soft | | 6 | 81 | 3 |
| 51 | Herrin (No. 6) coal | | | | |
| | Coal | 3 | | 84 | 3 |
| | "Sulphur" (pyrite?) | | 5 | 84 | 8 |
| | Coal | 3 | 4 | 88 | |
| 50 | "Fireclay," hard | 1 | 1 | 89 | 1 |

[1]Authority Thomas Fairbairne.

*7.—William Francis and Co. shaft,[1] French farm, SW. ¼ SW. ¼ SW. ¼ sec. 3, T. 31 N., R. 3 E. (Bruce Twp.), LaSalle County, Streator quadrangle.*

Elevation 644 feet

| Unit No. | | Thickness Ft. | Thickness In. | Depth Ft. | Depth In. |
|---|---|---|---|---|---|
| | Pleistocene system | | | | |
| | Black soil | 2 | | 2 | |
| | "Hardpan" (till) | 12 | | 14 | |
| | Clay (till), white | 14 | | 28 | |
| | "Hardpan" (till) | 21 | | 49 | |
| | Shale, soft | 1 | | 50 | |
| | "Hardpan" (till), brown | 3 | | 53 | |
| | "Hardpan" (till) | 11 | | 64 | |
| | Pennsylvanian system | | | | |
| | Brereton cyclothem | | | | |
| 57 | "Fireclay" and soft shale | 4 | | 68 | |
| " | Shale | 19 | | 87 | |
| 56 | Limestone | 2 | | 89 | |
| 54 | "Slate" (shale), black | 12 | | 101 | |
| 51 | Herrin (No. 6) coal | 9 | 4 | 110 | 4 |
| 50 | "Fireclay" | 8 | | 118 | 4 |

[1]Authority William T. Thomas.

*8.—Acme Coal Co. boring No. 4,[1] Henry Richards farm, NW. ¼ SE. ¼ SE. ¼ sec. 4, T. 31 N., R. 3 E. (Bruce Twp.), LaSalle County, Streator quadrangle.*

Elevation 643 feet

| Unit No. | | Thickness Ft. | Thickness In. | Depth Ft. | Depth In. |
|---|---|---|---|---|---|
| | Pleistocene system | | | | |
| | Soil | 3 | | 3 | |
| | Sand and clay | 5 | | 8 | |
| | Clay, blue | 7 | | 15 | |
| | "Hardpan" (till) | 10 | | 25 | |
| | Clay (till) | 12 | | 37 | |
| | "Hardpan" (till) | 18 | | 55 | |
| | Sand and clay | 5 | | 60 | |
| | Pennsylvanian system | | | | |
| | Brereton cyclothem | | | | |
| 56? | "Rock," hard, (limestone?), white | 2 | | 62 | |
| 52? | Shale, light | 18 | | 80 | |
| | "Rock" | 2 | | 82 | |
| | "Clod," black | | 2 | 82 | 2 |
| | Shale, dark | 2 | | 84 | 2 |
| 41 | Vermilionville sandstone, soft | 34 | 7 | 118 | 9 |
| | St. David cyclothem | | | | |
| 39 | "Slate" (shale), black | 2 | 3 | 121 | |
| | Summum cyclothem | | | | |
| | "Fireclay" | 2 | | 123 | |
| 27 | Shale, black | 3 | | 126 | |
| " | "Slate" (shale), black | | 6 | 126 | 6 |
| " | "Rock," hard (limestone) | | 4 | 126 | 10 |

[1]Authority Thomas Fairbairne.

*9.—Boring,[1] Freeman farm, SW. ¼ sec. 7, T. 31 N., R. 3 E. (Eagle Twp.), LaSalle County, Streator quadrangle.*

Elevation 650 feet

| Unit No. | | Thickness Ft. | Thickness In. | Depth Ft. | Depth In. |
|---|---|---|---|---|---|
| | Pleistocene system | | | | |
| | Soil | 1 | | 1 | |
| | Clay, yellow | 5 | | 6 | |
| | Clay and gravel | 1 | 6 | 7 | 6 |
| | Clay, blue, and hardpan (till) | 19 | 6 | 27 | |
| | Sand | 1 | | 28 | |
| | Pennsylvanian system | | | | |
| | Brereton cyclothem | | | | |
| 41 | Vermilionville sandstone | | | | |
| | Sandstone | 23 | 2 | 51 | 2 |
| | Shale and sandstone | 1 | 6 | 52 | 8 |
| | Sandstone | 20 | | 72 | 8 |
| | Limestone (sandstone?) | 3 | | 75 | 8 |
| | Sandstone with hard (limestone) bands | 7 | | 82 | 8 |
| | "Rock," hard | 1 | | 83 | 8 |
| | St. David cyclothem | | | | |
| 40 | Canton shale | | | | |
| | Shale | 7 | | 90 | 8 |
| | Shale, gray | 4 | | 94 | 8 |
| 39 | Shale, black | 2 | 2 | 96 | 10 |
| | Summum cyclothem | | | | |
| | "Flint rock," blue | 3 | | 99 | 10 |
| 28 | Hanover limestone, hard | 2 | | 101 | 10 |
| 27 | "Rock," hard, blue | 1 | 6 | 103 | 4 |
| " | "Rock," extra hard | | 3 | 103 | 7 |
| " | "Slate" (shale), black | 6 | 3 | 109 | 10 |
| 25 | "Fireclay" or clay shale | 6 | | 115 | 10 |
| 17 | Pleasantview sandstone | | | | |
| | Sandstone | 1 | | 116 | 10 |
| | Sandstone and shale | 1 | 6 | 118 | 4 |
| | Sandstone | 1 | 6 | 119 | 10 |
| | Lowell cyclothem | | | | |
| 12-16 | Shale, cream-colored, soft | 9 | 7 | 129 | 5 |
| 11 | "Slate" (shale) and coal | | 8 | 130 | 1 |
| " | "Sulphur" (pyrite) and "slate" (shale) | 1 | 6 | 131 | 7 |
| | Liverpool cyclothem | | | | |
| 8 | Shale, dark with hard (limestone) bands | 20 | | 151 | 7 |
| 6 | "Slate" (shale), black | 2 | | 153 | 7 |
| 3? | "Fireclay" | 1 | | 154 | 7 |

[1]Authority Thomas Fairbairne.

*10.—Boring No. 3,[1] SE. ¼ NE. ¼ NE. ¼ sec. 10, T. 31 N., R. 3 E. (Bruce Twp.), LaSalle County, Streator quadrangle.*

Elevation 645 feet

| Unit No. | | Thickness Ft. | Thickness In. | Depth Ft. | Depth In. |
|---|---|---|---|---|---|
| | Pleistocene system | | | | |
| | "Surface" (soil and till) | 22 | | 22 | |
| | Sand | 31 | | 53 | |
| | "Rock" | 2 | | 55 | |
| | "Hardpan" (till) | 23 | | 78 | |
| | Sand | 11 | | 89 | |
| | Pennsylvanian system | | | | |
| | Brereton cyclothem | | | | |
| 52 | Shale | 44 | | 133 | |
| 51 | Herrin (No. 6) coal | 1 | 8 | 134 | 8 |

[1]Authority F. H. Renz, Streator City Engineer.

*11.—Chicago, Wilmington, and Vermilion Coal Co. No. 1 shaft, SE. ¼ NW. ¼ sec. 10, T. 31 N., R. 3 E. (Bruce Twp.), LaSalle County, Streator quadrangle.*

Elevation 640 feet

| Unit No. | | Thickness Ft. | In. | Depth Ft. | In. |
|---|---|---|---|---|---|
| | Filled ground | 4 | | 4 | |
| | Pleistocene system | | | | |
| | Soil, black | 1— | 6 | 5— | 6 |
| | Clay, yellow | 9— | 6 | 15 | |
| | Silt and sand | 3— | 6 | 18— | 6 |
| | "Hardpan" (till) | 12— | 6 | 31 | |
| | Clay, blue (till?) | 10 | | 41 | |
| | "Hardpan" (till) | 14 | | 55 | |
| | Pennsylvanian system | | | | |
| | Sparland cyclothem | | | | |
| 58? | Shale | 2 | | 57 | |
| 58 | Copperas Creek sandstone, hard | 2 | | 59 | |
| | Brereton cyclothem | | | | |
| 57 | Shale, and boulders | 4— | 6 | 63— | 6 |
| 56 | "Flint rock," hard (Brereton limestone) | 2— | 6 | 66 | |
| 55 | Shale, dark | 1 | | 67 | |
| 54 | Shale, black | 10 | | 77 | |
| 52 | Shale, gray | 15 | | 92 | |
| 51 | Herrin (No. 6) coal | 9 | | 101 | |
| 48 | "Slate" (shale), black | 2 | | 103 | |
| 41 | Vermilionville sandstone, hard | 25 | | 128 | |
| | St. David cyclothem | | | | |
| 40 | Canton shale | | | | |
| | Coal and "slate" (shale) | 1 | | 129 | |
| | shale, dark | 13 | | 142 | |
| 39 | "Slate" (shale), black | 2— | 6 | 144— | 6 |
| | Summum cyclothem | | | | |
| 27-28 | "Flint rock" (limestone, siliceous shale) | 5— | 6 | 150 | |
| 27 | "Slate" (shale), black | 2— | 6 | 152— | 6 |
| 26 | Summum (No. 4) coal, poor | 1— | 6 | 154 | |
| 25 | "Fireclay" and "boulders" (limestone?) | 4 | | 158 | |
| 24? | Shale, gray | 4 | | 162 | |
| 23? | Sandstone (limestone?), hard | 1 | | 163 | |
| 22? | Shale, gray | 2 | | 165 | |
| 19-21? | "Slate" (shale), black | | 2 | 165— | 2 |
| 18? | Shale, gray | 3 | | 168— | 2 |
| 17 | Pleasantview sandstone | | | | |
| | Sandstone, hard | 1—10 | | 170 | |
| | Shale, gray | 3 | | 173 | |
| | Sandstone, dark | 3 | | 176 | |
| | Lowell cyclothem | | | | |
| 11 | "Slate" (shale), black | 3— | 6 | 179— | 6 |
| | Liverpool cyclothem | | | | |
| 5 | Clay-shale (Francis Creek) | 27— | 7 | 207— | 1 |
| 4 | LaSalle (No. 2) coal | 2—10 | | 209—11 | |
| 3 | "Fireclay" | 8 | | 217—11 | |
| | Undifferentiated | | | | |
| | Sandstone | 9 | | 226—11 | |
| | Shale, dark | 27 | | 255—11 | |
| | Ordovician system | | | | |
| | Galena formation | | | | |
| | Limestone | 12 | | 265—11 | |

*12.—Star Coal Co. boring, NE. ¼ sec. 21, T. 31 N., R. 3 E. (Eagle Twp.), LaSalle County, Streator quadrangle.*

Elevation 620 feet

| Unit No. | | Thickness Ft. | In. | Depth Ft. | In. |
|---|---|---|---|---|---|
| | Pleistocene system | | | | |
| | Soil | 1— | 6 | 1— | 6 |
| | Clay, yellow | 10— | 6 | 12 | |
| | Clay, blue | 4 | | 16 | |
| | Sand and water | 2 | | 18 | |
| | Clay and gravel | 11— | 6 | 29— | 6 |
| | Clay, blue | 3 | | 32— | 6 |
| | Sand and water | | 6 | 33 | |
| | "Hardpan" (till) | 18 | | 51 | |
| | Pennsylvanian system | | | | |
| | Brereton cyclothem | | | | |
| 54 | "Slate" (shale), soft | 1 | | 52 | |
| " | "Slate" (shale), black | 2—10 | | 54—10 | |
| 51 | Herrin (No. 6) coal | 6— | 6 | 61— | 4 |
| 48 | "Slate" (shale), black | 3—10 | | 65— | 2 |
| 41 | Vermilionville sandstone | | | | |
| | Sandstone, soft | 2— | 6 | 67— | 8 |
| | Sandstone, hard | 3 | | 70— | 8 |
| | Sandstone, soft | 17 | | 87— | 8 |
| | St. David cyclothem | | | | |
| 40 | Canton shale | | | | |
| | "Slate" (shale), gray | 23 | | 110— | 8 |
| | Shale | 14 | | 124— | 8 |
| | "Slate" (shale), black | 1 | | 125— | 8 |
| | Coal | | 1 | 125— | 9 |
| | "Slate" (shale), gray | 9 | | 134— | 9 |
| 39 | "Slate" (shale), black | 3 | | 137— | 9 |
| | Summum cyclothem | | | | |
| 28-29 | "Rock," hard (limestone?) | 1—10 | | 139— | 7 |
| " | "Fireclay" | 2— | 8 | 142— | 3 |
| 27 | "Rock," hard | 6— | 2 | 148— | 5 |
| 26 | Summum (No. 4) coal | 2— | 6 | 150—11 | |
| 25 | "Fireclay" | 3 | | 153—11 | |
| 17 | Pleasantview sandstone | | | | |
| | "Rock," hard (sandstone?) | 3 | | 156—11 | |
| | Sandstone, clayey | 4— | 7 | 161— | 6 |
| | Lowell cyclothem | | | | |
| 12-16 | Shale, blue, soft | 7—10 | | 169— | 4 |
| 11 | Coal, "slaty" | 2— | 9 | 172— | 1 |
| | Liverpool cyclothem | | | | |
| 5 | Francis Creek shale | | | | |
| | Shale, dark, hard, gas | 7— | 7 | 179— | 8 |
| | Shale | 16— | 7 | 196— | 3 |
| 4 | LaSalle (No. 2) coal | | | | |
| | Coal | 2— | 5 | 198— | 8 |
| | Coal and "slate" (shale) | | 6 | 199— | 2 |
| 3 | "Fireclay" | 1— | 8 | 200—10 | |
| | Undifferentiated | | | | |
| | Sandstone | | 10 | 201— | 8 |

*13.—Acme Coal Co. boring,[1] SW. ¼ NE. ¼ sec. 21, T. 31 N., R. 3 E. (Eagle Twp.), LaSalle County, Streator quadrangle.*

Elevation 620 feet

| Unit No. | | Thickness Ft. | In. | Depth Ft. | In. |
|---|---|---|---|---|---|
| | Pleistocene system | | | | |
| | Soil and clay (till?) | 37— | 6 | 37— | 6 |
| | Pennsylvanian system | | | | |
| | Brereton cyclothem | | | | |
| 57 | Shale | 27 | | 64— | 6 |
| 54 | "Slate" (shale), black | 3 | | 67— | 6 |
| 51 | Herrin (No. 6) coal | 4— | 6 | 72 | |

| Unit No. | | Thickness Ft. | Thickness In. | Depth Ft. | Depth In. |
|---|---|---|---|---|---|
| 41 | Vermilionville sandstone | 14 | | 86 | |
| | St. David cyclothem | | | | |
| 40 | Canton shale | | | | |
| | "Slate" (shale), gray . | 24 | | 110 | |
| | "Rock", hard . . . . | 4 | | 114 | |
| | "Rock", with soft layers | 2 | | 116 | |
| 39 | Coal and "slate" (shale), black . . . . . . . | 3— | 9 | 119— | 9 |
| | Summum cyclothem | | | | |
| 29? | "Fireclay" . . . . . . | 8— | 6 | 128— | 3 |
| 27-28 | "Rock" (limestone and siliceous shale), hard | 5— | 6 | 133— | 9 |
| | Lowell cyclothem | | | | |
| 12-16 | Shale, soft . . . . . | 8— | 9 | 142— | 6 |
| 11 | Coal and "slate" (shale) | 3— | 8 | 146— | 2 |
| | Liverpool cyclothem | | | | |
| 8 | Shale, black . . . . . . | 7— | 5 | 153— | 7 |
| 6 | "Slate" (shale), black . | 7— | 4 | 160— | 11 |
| 5 | Francis Creek shale . . | 15 | | 175— | 11 |
| 4 | LaSalle (No. 2) coal . . | 2— | 9 | 178— | 8 |
| 3 | "Fireclay," very hard . | 1 | | 179— | 8 |

[1]Authority Thomas Fairbairne.

*14.—Acme Coal Co. boring,[1] Louis Kraft farm, NW. ¼ sec. 21, T. 31 N., R. 3 E. (Eagle Twp.), LaSalle County, Streator quadrangle.*

Elevation 630 feet

| Unit No. | | Thickness Ft. | Thickness In. | Depth Ft. | Depth In. |
|---|---|---|---|---|---|
| | Pleistocene system | | | | |
| | Soil, black . . . . . . | 3 | | 3 | |
| | Clay . . . . . . . . . . | 6 | | 9 | |
| | "Hardpan" (till) with gravel . . . . . . . | 21 | | 30 | |
| | Pennsylvanian system | | | | |
| | Brereton cyclothem | | | | |
| 41 | Vermilionville sandstone | | | | |
| | Sandstone rock . . . | 1 | | 31 | |
| | Sandstone, soft, hard layers . . . . . . | 10 | | 41 | |
| | St. David cyclothem | | | | |
| 40 | Canton shale | | | | |
| | Shale, soft . . . . . | 20 | | 61 | |
| | Shale, with hard bands | 40 | | 101 | |
| 39? | "Rock," hard . . . . . | 5 | | 106 | |
| | Summum cyclothem | | | | |
| 27 | Shale, hard . . . . . . | 12 | | 118 | |
| 26 | Coal streak, "bone" and "slate" (shale), black | | 10 | 118— | 10 |
| 25 | "Fireclay" . . . . . . | 3 | | 121— | 10 |
| 17 | Sandstone . . . . . . | 8 | | 129— | 10 |
| | Lowell cyclothem | | | | |
| 12-16 | Shale . . . . . . . . | 20— | 2 | 150 | |
| 11 | "Slate" (shale), black . | 1— | 6 | 151— | 6 |
| 10 | "Fireclay" . . . . . . | 2 | | 153— | 6 |
| | Liverpool cyclothem | | | | |
| 8 | Shale . . . . . . . . . | 6— | 6 | 160 | |
| 6 | "Slate" (shale), black . | 2 | | 162 | |
| 5 | Francis Creek shale, soft | 10 | | 172 | |
| 4 | LaSalle (No. 2) coal . . | 2— | 2 | 174— | 2 |
| 3 | Clay . . . . . . . . . . | 6 | | 180— | 2 |

[1]Authority Thomas Fairbairne.

*15.—Chicago, Wilmington, and Vermilion Coal Co. boring at Mine No. 3, SE. ¼ NW. ¼ SW. ¼ sec. 24, T. 31 N., R. 3 E. (Bruce Twp.), LaSalle County, Streator quadrangle.*

Elevation 632 feet

| Unit No. | | Thickness Ft. | Thickness In. | Depth Ft. | Depth In. |
|---|---|---|---|---|---|
| | Pleistocene system | | | | |
| | "Surface" material . . . | 6 | | 6 | |
| | Sand and gravel . . . . | 8 | | 14 | |
| | Clay, blue (till) . . . . | 43 | | 57 | |
| | Pennsylvanian system | | | | |
| | Brereton cyclothem | | | | |
| 52 | Shale, sandy, soft . . . | 14— | 6 | 71— | 6 |
| 51 | Herrin (No. 6) coal . . | 4— | 6 | 76 | |
| 48 | "Slate" (shale), black . | 1 | | 77 | |
| 42 | "Fireclay" . . . . . . | 4 | | 81 | |
| 41 | Vermilionville sandstone | | | | |
| | Shale, sandy . . . . | 2 | | 83 | |
| | Sandstone . . . . . | 25 | | 108 | |
| | St. David cyclothem | | | | |
| 40 | Canton shale | | | | |
| | Shale, dark, with limestone partings . . . | 19— | 6 | 127— | 6 |
| | "Slate" (shale), black . | 2— | 6 | 130 | |
| | Shale, dark, with limestone partings . . . | 18 | | 148 | |
| 39 | "Slate" (shale), black . . | 3 | | 151 | |
| | Summum cyclothem | | | | |
| 28–29 | Limestone, dark . . . | 1— | 9 | 152— | 9 |
| " | "Fireclay" and limestone mixed . . . | 5— | 3 | 158 | |
| 27 | Shale, blue . . . . . . | 3 | | 161 | |
| " | "Slate" (shale), black . . | 1— | 6 | 162— | 6 |
| 26 | Summum (No. 4) coal . | 2— | 6 | 165 | |
| 25 | "Fireclay," dark . . . . | 5 | | 170 | |
| 17? | "Fireclay" and limestone (sandstone?) . . . | 7 | | 177 | |
| | "Fireclay" . . . . . | 2 | | 179 | |
| | Lowell cyclothem | | | | |
| 12–16 | Shale, dark . . . . | 3— | 3 | 182— | 3 |
| 11 | Coal . . . . . . . . . . | 1 | | 183— | 3 |
| 9 | Limestone, sandy (sandstone?), with coal partings . . . . . . . . | | 9 | 184 | |
| " | Limestone (sandstone?), dark . . . . . . . . | | 9 | 184— | 9 |
| | Liverpool cyclothem | | | | |
| 8 | Shale, dark . . . . . . | 13— | 3 | 198 | |
| 6 | "Slate" (shale), black . . | 3 | | 201 | |
| 5 | Francis Creek shale | | | | |
| | Shale, dark . . . . . | 2 | | 203 | |
| | Clay shale, blue . . . | 8 | | 211 | |
| | Clay shale, light . . . | 4— | 6 | 215— | 6 |
| 4 | LaSalle (No. 2) coal . . | 3 | | 218— | 6 |
| 3 | "Fireclay" . . . . . . | 3— | 6 | 222 | |
| | Undifferentiated | | | | |
| | Limestone, sandy . . . | 2 | | 224 | |
| | Sandstone . . . . . . | 7 | | 231 | |
| | Limestone . . . . . . | 2 | | 233 | |
| | "Slate" (shale), black . . | | 9 | 233— | 9 |
| | Coal, soft . . . . . . . | 1— | 9 | 235— | 6 |
| | "Fireclay," sandy . . . | 1— | 6 | 237 | |
| | Sandstone . . . . . . | 3 | | 240 | |

*16.—Coal Run Coal Co. Peanut No. 2 shaft,*[1] *near center SE. ¼ sec. 35, T. 31 N., R. 3 E. (Bruce Twp.), LaSalle County, Streator quadrangle.*

Elevation 615 feet

| Unit No. | | Thickness Ft. | In. | Depth Ft. | In. |
|---|---|---|---|---|---|
| | Pleistocene system | | | | |
| | "Surface" material | 22 | | 22 | |
| | Pennsylvanian system | | | | |
| | Brereton cyclothem | | | | |
| 52 | Shale | 29 | | 51 | |
| 51 | Herrin (No. 6) coal | 5 | | 56 | |
| 42–48 | "Slate" (shale), black | 1 | | 57 | |
| " | "Fireclay" | 3 | | 60 | |
| " | "Slate" (shale) | 2— | 6 | 62— | 6 |
| " | "Fireclay" | 3 | | 65— | 6 |
| 41 | Vermilionville sandstone | 14 | | 79— | 6 |
| | St. David cyclothem | | | | |
| 40 | "Slate" (shale), black and light | 26— | 6 | 106 | |
| 39 | "Slate" (shale), black and light | 2 | | 108 | |
| | Summum cyclothem | | | | |
| 28? | "Stone," hard (Hanover limestone?) | 2 | | 110 | |
| 27? | "Slate" (shale) | 17 | | 127 | |
| | Lowell cyclothem | | | | |
| 12–16? | "Stone," red, some "ironstone" | 10 | | 137 | |
| " | "Slate" (shale), black | 2 | | 139 | |
| 11 | Coal | 2— | 6 | 141— | 6 |
| 10 | "Fireclay" | 11 | | 152— | 6 |
| 9? | "Stone," hard | 4 | | 156— | 6 |
| | Liverpool cyclothem | | | | |
| 8 | Limestone | 2 | | 158— | 6 |
| " | "Slate" (shale) | 8 | | 166— | 6 |
| 6 | "Slate" (shale), black with gas | 4 | | 170— | 6 |
| 5 | "Slate" (shale), light, and "fireclay" (Francis Creek shale) | 10 | | 180— | 6 |
| 4 | LaSalle (No. 2) coal | 2 | | 182— | 6 |
| 3 | "Fireclay" | 2— | 6 | 185 | |
| | Undifferentiated | | | | |
| | "Slate" (shale), light | 20— | 6 | 205— | 6 |
| | "Slate" (shale), dark, with hard stone | 15— | 6 | 221 | |
| | Ordovician system | | | | |
| | Galena formation | | | | |
| | Limestone | 9 | | 230 | |

[1]Authority F. Plumb.

*17.—Chicago, Wilmington and Vermilion Coal Co. Mine No. 2 shaft, SW. ¼ sec. 19, T. 31 N., R. 4 E. (Otter Creek Twp.), LaSalle County, Streator quadrangle.*

Elevation 630 feet

Record A[1]

| Unit No. | | Thickness Ft. | In. | Depth Ft. | In. |
|---|---|---|---|---|---|
| | Pleistocene system | | | | |
| | Soil, black | 1— | 6 | 1— | 6 |
| | Clay, yellow (till) | 8— | 6 | 10 | |
| | Clay, blue (till) | 10 | | 20 | |
| | Sand and silt | 20 | | 40 | |
| | "Hardpan" (till) | 17 | | 57 | |
| | Pennsylvanian system | | | | |
| | Brereton cyclothem | | | | |
| 56? | "Flint rock" (limestone?) | 2— | 6 | 59— | 6 |
| 52 | Shale, sandy | 44 | | 103— | 6 |
| 51 | Herrin (No. 6) coal | 5 | | 108— | 6 |
| 43-48 | "Slate" (shale), black | 2— | 6 | 111 | |
| " | "Slate" (shale), gray | 3— | 6 | 114— | 6 |
| " | "Slate" (shale), coaly | 2 | | 116— | 6 |
| " | Shale, gray | 13 | | 129— | 6 |
| " | "Slate" (shale), black | 6 | | 135— | 6 |
| | St. David cyclothem | | | | |
| 40 | Canton shale, gray | 28 | | 163— | 6 |
| 39 | "Slate" (shale), black | 2 | | 165— | 6 |
| | Summum cyclothem | | | | |
| 27-29 | Sandstone, hard | 5 | | 170— | 6 |
| " | Shale, with "boulders" (limestone?) | 16 | | 186— | 6 |
| " | "Slate" (shale), black | | 3 | 186— | 9 |
| 26 | Summum (No. 4) coal | 2— | 6 | 189— | 3 |
| 25 | "Fireclay" | 4 | | 193— | 3 |
| 17 | Pleasantview sandstone, hard | 6 | | 199— | 3 |
| | Lowell cyclothem | | | | |
| 12-16 | Shale, gray | 9 | | 208— | 3 |
| 11 | Coal | 2— | 6 | 210— | 9 |
| 9 | Sandstone, hard | 1 | | 211— | 9 |
| | Liverpool cyclothem | | | | |
| 8 | Shale, dark | 10— | 6 | 222— | 3 |
| 6 | "Slate" (shale), black | 3 | | 225— | 3 |
| 5 | Francis Creek shale | | | | |
| | "Fireclay" (shale?) | 3 | | 228— | 3 |
| | Shale, gray | 16 | | 244— | 3 |
| 4 | LaSalle (No. 2) coal | 3— | 4 | 247— | 7 |
| 3 | "Fireclay" | 7 | | 254— | 7 |
| | "Slate" (shale), black | 2— | 7 | 257— | 2 |

[1]Note that another record for the shaft of Mine No. 2 (record B following this record) differs in the description of the Pennsylvanian system. Record A is probably of the hoisting shaft near the SE. corner NE. ¼ SW. ¼ sec. 19, and record B of the original shaft to coal No. 6, about a quarter mile west, which was deepened to coal No. 2.

Record B

| Unit No. | | Thickness Ft. | In. | Depth Ft. | In. |
|---|---|---|---|---|---|
| | No record to the base of coal | | | 116 | |
| | Pennsylvanian system | | | | |
| | Brereton cyclothem | | | | |
| 43-48 | "Slate" (shale) | 2 | | 118 | |
| " | "Fireclay" | 2— | 6 | 120— | 6 |
| " | Shale | 6 | | 126— | 6 |
| " | "Slate" (shale) | 1— | 6 | 128 | |
| " | Shale | 6 | | 134 | |
| " | Sandstone | 2— | 6 | 136— | 6 |
| " | Coal | | 3 | 136— | 9 |
| " | "Slate" (shale) | 12 | | 148— | 9 |
| | St. David cyclothem | | | | |
| 40 | Canton shale | | | | |
| | Shale | 25 | | 173— | 9 |
| | "Granite" (limestone?), blue | 2— | 9 | 176— | 6 |
| | Shale | 3 | | 179— | 6 |
| | Shale, "flinty" | 5— | 6 | 185 | |
| 39 | "Slate" (shale) | 4 | | 189 | |
| | Summum cyclothem | | | | |
| 28-35 | Sandstone (limestone and shale?) | 3 | | 192 | |
| 27 | "Slate" (shale) | 1— | 6 | 193— | 6 |
| 26 | Summum (No. 4) coal | 2— | 6 | 196 | |
| 25 | "Fireclay" | 3 | | 199 | |
| 17 | Pleasantview sandstone | 3 | | 202 | |
| 17? | Limestone (sandstone?), blue | 3 | | 205 | |

| Unit No. | | Thickness Ft. In. | Depth Ft. In. |
|---|---|---|---|
| | Lowell cyclothem | | |
| 12-16 | Shale, with "boulders" (limestone?) | 15— 6 | 220— 6 |
| 11 | Coal | 2— 4 | 222—10 |
| | Liverpool cyclothem | | |
| 8 | Shale, blue | 14 | 236—10 |
| 6 | "Slate" (shale) | 5 | 241—10 |
| 5 | Francis Creek shale | 21 | 262—10 |
| 4 | LaSalle (No. 2) coal | 4 | 266—10 |

*21.—Coal Run Coal Co. boring No. 15,*[1] *Christian Baker Farm, Center SE. ¼ NW. ¼ sec. 30, T. 31 N., R. 4 E. (Otter Creek Twp.), LaSalle County, Streator quadrangle.*

Elevation 640 feet

| Unit No. | | Thickness Ft. In. | Depth Ft. In. |
|---|---|---|---|
| | Pleistocene system | | |
| | Soil and clay (till) | 20 | 20 |
| | Sand | 12 | 32 |
| | Clay, blue (till) | 14 | 46 |
| | Pennsylvanian system | | |
| | Brereton cyclothem | | |
| 53 | Sandstone and shale mixed | 15 | 61 |
| 52 | Shale | 58 | 119 |
| 51 | Herrin (No. 6) coal | 5—2½ | 124—2½ |

[1]Authority F. Plumb.

*24.—Acme Coal Co. shaft,*[1] *NW. ¼ NW. ¼ sec. 31, T. 31 N., R. 4 E. (Otter Creek Twp.), LaSalle County, Streator quadrangle.*

Elevation 620 feet

| Unit No. | | Thickness Ft. In. | Depth Ft. In. |
|---|---|---|---|
| | Pleistocene system | | |
| | Soil | 3 | 3 |
| | Clay, yellow (till) | 7 | 10 |
| | "Hardpan" (till) | 10 | 20 |
| | Sand | 20 | 40 |
| | Sparland cyclothem | | |
| | Copperas Creek sandstone | 20 | 60 |
| | Brereton cyclothem | | |
| 52 | Shale, soft | 10 | 70 |
| " | Shale, hard | 33 | 103 |
| 51 | Herrin (No. 6) coal | 7 | 110 |
| 48 | "Slate" (shale), black | 2 | 112 |
| 42 | "Fireclay" | 8 | 120 |

[1]Authority Thomas Fairbairne; record from memory.

*27.—Streator Clay Manufacturing Co. boring, sec. 6, T. 30 N., R. 4 E. (Newtown Twp.), Livingston County, Streator quadrangle.*

Elevation 615 feet

| Unit No. | | Thickness Ft. In. | Depth Ft. In. |
|---|---|---|---|
| | Pleistocene system | | |
| | Soil | 10 | 10 |
| | "Hardpan" and blue clay (till) | 12 | 22 |
| | Pennsylvanian system | | |
| | Brereton cyclothem | | |
| 53 | Sandstone, soft | 5 | 27 |
| 52 | Shale | 33— 3 | 60— 3 |
| 51 | Herrin (No. 6) coal in 2 benches with clay "split" | 5— 3 | 65— 6 |
| 50 | "Fireclay" | 2 | 67— 6 |
| 41 | Vermilionville sandstone "Rock," irregular | 11—10 | 79— 4 |
| | "Slate" (shale), gray | 17— 2 | 96— 6 |
| | Shale | 1— 5 | 97—11 |
| | "Slate" (shale), gray | 8 | 105—11 |
| | Coal | 1 | 106—11 |
| | Shale | 7 | 113—11 |
| | "Rock" | 2— 9 | 116— 8 |
| | St. David cyclothem | | |
| 40 | Canton shale | | |
| | Shale | 2— 6 | 119— 2 |
| | Shale, dark | 8 | 127— 2 |
| | "Slate" (shale), black | 2 | 129— 2 |
| | Shale | 16— 6 | 145— 8 |
| 39 | "Slate" (shale), black | 2 | 147— 8 |
| | Summum cyclothem | | |
| 27-35 | "Rock," hard | 3 | 150— 8 |
| " | Sandstone, clayey | 6— 9 | 157— 5 |
| " | Shale, dark | 2 | 159— 5 |
| " | "Rock," hard | 8 | 160— 1 |
| " | Shale | 3 | 160— 4 |
| 26 | Summum (No. 4) coal | 3 | 163— 4 |
| 25 | "Fireclay" | 4 | 167— 4 |
| | Lowell cyclothem | | |
| 12-16 | Shale | 9— 9 | 177— 1 |
| 11 | Coal | 1 | 178— 1 |
| | Liverpool cyclothem | | |
| 8 | Shale, dark | 18 | 196— 1 |
| 6 | "Slate" (shale), black | 6— 4 | 202— 5 |
| 5 | Francis Creek shale | 18—10 | 221— 3 |
| 4 | Mixture [includes LaSalle (No. 2) coal?] | 13— 6 | 234— 9 |

*31.—Streator Clay Manufacturing Co. boring, NE. ¼ SE. ¼ SE. ¼ sec. 1, T. 30 N., R. 3 E. (Reading Twp.), Livingston County, Streator quadrangle.*

Elevation 612 feet

| Unit No. | | Thickness Ft. In. | Depth Ft. In. |
|---|---|---|---|
| | Pleistocene system | | |
| | Soil and clay | 12— 6 | 12— 6 |
| | Clay, gravel, water-bearing | 2— 6 | 15 |
| | Sand | 6 | 15— 6 |
| | Clay, blue | 2— 9 | 18— 3 |
| | "Quicksand" | 6 | 24— 3 |
| | Pennsylvanian system | | |
| | Brereton cyclothem | | |
| 52 | Shale, soft | 10 | 34— 3 |
| " | Shale, hard | 40— 3 | 74— 6 |
| 51 | Herrin (No. 6) coal with 15-inch clay "split" | 5— 6 | 80 |
| 50 | "Fireclay" | 1— 4 | 81— 4 |
| 41 | Vermilionville sandstone | | |
| | Sandstone | 8—11 | 90— 3 |
| | "Slate" (shale), gray | 27— 6 | 117— 9 |
| | Shale | 2 | 119— 9 |
| | Coal | 6 | 120— 3 |
| | Shale | 7—11 | 128— 2 |
| | "Slate" (shale), black | 6 | 128— 8 |
| | Coal | 1—10 | 130— 6 |
| | "Fireclay" | 6 | 131 |
| | "Rock" (sandstone?) | 3— 6 | 134— 6 |
| | Limestone, hard (sandstone?) | 7— 5 | 141—11 |
| | St. David cyclothem | | |
| 40 | Canton shale, dark | 16 | 157—11 |
| 39 | "Slate" (shale), black | 1— 7 | 159— 6 |
| | Summum cyclothem | | |

| Unit No. | | Thickness Ft. In. | Depth Ft. In. |
|---|---|---|---|
| 27-35 | "Rock," hard (limestone?) | 3— 1 | 162— 7 |
| " | Sandstone, clayey, with hard streaks | 8— 1 | 170— 8 |
| " | Shale, dark, soft | 1—10 | 172— 6 |
| " | "Rock," hard (limestone) | 10 | 153— 4 |
| " | Shale | 3 | 173— 7 |
| 26 | Summum (No. 4) coal | 2— 7 | 176— 2 |
| 25 | "Fireclay" | 4— 1 | 180— 3 |
| | Lowell cyclothem | | |
| 12-16 | Shale | 8— 8 | 188—11 |
| " | Rock | 1 | 189—11 |
| " | Shale | 4 | 190— 3 |
| 11 | Coal | 1 | 191— 3 |
| " | "Sulphur" (pyrite), hard | 6 | 191— 9 |
| | Liverpool cyclothem | | |
| 8 | Shale, dark, soft | 11 | 202— 9 |
| 6 | "Slate" (shale), black, with gas | 2 | 204— 9 |
| 5 | Francis Creek shale | 15— 6 | 220— 3 |
| 4 | LaSalle (No. 2) coal | 2— 1 | 222— 4 |
| 3 | "Fireclay" | 5— 8 | 228 |
| | Shale | 1 | 229 |

*32.—Streator Brick Co. boring, 800 feet west of Vermilion River, NW. ¼ SE. ¼ SW. ¼ sec. 7, T. 30 N., R. 4 E. (Newtown Twp.), Livingston County, Streator quadrangle.*

Elevation 585 feet

| Unit No. | | Thickness Ft. In. | Depth Ft. In. |
|---|---|---|---|
| | Pleistocene system | | |
| | Loam | 1 | 1 |
| | Clay, yellow | 5 | 6 |
| | Sand, yellow | 3 | 9 |
| | Sand, gray | 4 | 13 |
| | Pennsylvanian system | | |
| | Gimlet cyclothem | | |
| 62 | Sandstone | 2— 6 | 15— 6 |
| | Sparland cyclothem | | |
| 61 | Farmington shale | 2— 6 | 18 |
| 60 | Sparland (No. 7) coal | 2 | 20 |
| 59 | "Fireclay" | 8 | 28 |

*33.—Boring No. 1,[1] James Daugherty farm, NW. ¼ sec. 6, T. 30 N., R. 4 E.[2] (Newtown Twp.), Livingston County, Streator quadrangle.*

Elevation 620 feet

| Unit No. | | Thickness Ft. In. | Depth Ft. In. |
|---|---|---|---|
| | Pleistocene system | | |
| | Loam, black | 2— 6 | 2— 6 |
| | Clay, yellow | 6 | 8— 6 |
| | Clay, bouldery (till) | 7— 6 | 16 |
| | Clay, blue (till) | 7 | 23 |
| | Pennsylvanian system | | |
| | Gimlet cyclothem | | |
| 62 | Sandstone, soft | 4 | 27 |
| | Sparland cyclothem | | |
| 60 | Sparland (No. 7) coal | 2— 8 | 29— 8 |
| 59 | "Fireclay" | 9 | 38— 8 |
| | Sparland and Brereton cyclothems | | |
| 52-58 | Sandstone | 26— 9 | 65— 5 |
| | Brereton cyclothem | | |
| 51 | Herrin (No. 6) coal | 4— 8 | 70— 1 |
| 50 | "Fireclay" | 12—11 | 83 |
| 41 | Vermilionville sandstone, clayey | 23 | 106 |
| | St. David cyclothem | | |
| 40 | Canton shale | | |
| | Shale, sandy | 36 | 142 |
| | Coal, cannel | 2 | 142— 2 |
| | Shale, sandy | 4— 4 | 146— 6 |
| | Sandstone, soft | 2— 6 | 149 |
| | Shale, sandy | 1 | 150 |
| 39 | "Slate" (shale), black | 4— 1 | 154— 1 |
| | Summum cyclothem | | |
| 27-35 | "Fireclay" | 1— 6 | 155— 7 |
| " | Limestone, blue | 1—10 | 157— 5 |
| " | Shale, sandy, limy | 10— 7 | 168 |
| " | "Slate" (shale), blue | 3— 5 | 171— 5 |
| 26 | Summum (No. 4) coal | 5 | 171—10 |
| 25 | "Fireclay" | 2— 2 | 174 |
| | Lowell cyclothem | | |
| 12-16 | Shale | 17— 9 | 191— 9 |
| 11 | Coal | 3— 3 | 195 |
| | Liverpool cyclothem | | |
| 8 | Shale | 16— 6 | 211— 6 |
| 6 | "Slate" (shale), blue, hard, sulphur | 7— 6 | 219 |
| 5 | Francis Creek shale | 7 | 226 |
| 4 | LaSalle (No. 2) coal | 6 | 226— 6 |
| 3 | "Fireclay" | 3 | 229 |
| 3 | "Fireclay," concretionary | 5— 6 | 235 |
| | Undifferentiated | | |
| | Shale, limy | 36 | 271 |
| | Ordovician system | | |
| | Galena-Platteville formations | | |
| | Limestone | 236 | 507 |
| | St. Peter sandstone | | |
| | Sandstone | 10 | 517 |

[1]Authority C. S. Cummings.
[2]This location is questionable but is the one considered most logical geologically of five reported for essentially the same record.

*36.—Coal Run Coal Co. boring No. 2,[1] SE. ¼ SW. ¼ NW. ¼ sec. 11, T. 30 N., R. 3 E. (Reading Twp.), Livingston County, Streator quadrangle.*

Elevation 612 feet

| Unit No. | | Thickness Ft. In. | Depth Ft. In. |
|---|---|---|---|
| | Pleistocene system | | |
| | Soil | 8 | 8 |
| | Pennsylvanian system | | |
| | Sparland cyclothem? | | |
| 58? | Copperas Creek sandstone, soft | 8 | 16 |
| | Brereton cyclothem | | |
| 52 | Shale | 31 | 47 |
| 51 | Herrin (No. 6) coal | 3— 8 | 50— 8 |

[1]Authority F. Plumb.

*38.—Streator Brick Co. test-pit, 100 ft. north of Moon Creek, SE. ¼ SE. ¼ SE. ¼ sec. 10, T. 30 N., R. 3 E. (Reading Twp.), Livingston County, Streator quadrangle.*

Elevation 610 feet

| Unit No. | | Thickness Ft. In. | Depth Ft. In. |
|---|---|---|---|
| | Pleistocene system | | |
| | Loam, black | 1— 6 | 1— 6 |
| | Clay, sandy, yellow | 1— 9 | 3— 3 |
| | Pennsylvanian system | | |
| | Sparland cyclothem | | |
| 61 | Farmington shale | | |
| | Shale, light brown | 2 | 5— 3 |
| | "Slate" (shale), dark blue | 2 | 7— 3 |
| 60 | Sparland (No. 7) coal | 2 | 9— 3 |

| Unit No. | | Thickness Ft. In. | Depth Ft. In. |
|---|---|---|---|
| 59 | "Fireclay," light gray | 3 | 12— 3 |
| " | "Fireclay," green, few small pebbles | 3 | 15— 3 |
| " | "Fireclay," dark greenish-brown with pebbles | 3 | 18— 3 |
| " | Clay, sandy, green, with pebbles | 1— 4 | 19— 7 |
| 58? | Copperas Creek sandstone? | | |
| | Shale, sandy, green | 9— 3 | 28—10 |
| | Sandstone, hard | 6 | 29— 4 |
| | Shale, sandy, green | 1— 6 | 30—10 |

*39.—Wilmington Star Mining Co. boring,*[1] *NE. ¼ NE. ¼ NW. ¼ sec. 17, T. 32 N., R. 8 E. (Main Twp.), Grundy County, Morris quadrangle.*

Elevation 560 feet

| Unit No. | | Thickness Ft. In. | Depth Ft. In. |
|---|---|---|---|
| | Pleistocene system | | |
| | Soil, black | 2 | 2 |
| | Sand | 5— 6 | 7— 6 |
| | "Hard-pan" (till) | 8 | 15— 6 |
| | Sand and gravel | 8 | 23— 6 |
| | Pennsylvanian system | | |
| | Brereton cyclothem | | |
| 41 | Vermilionville sandstone | 12 | 35— 6 |
| | St. David cyclothem | | |
| 40 | Canton shale | | |
| | Shale | 8 | 43— 6 |
| | Sandstone | 6 | 44 |
| | Shale | 6 | 44— 6 |
| 39 | "Slate" (shale), black | 3 | 47— 6 |
| | Summum cyclothem | | |
| 29 | "Fireclay" | 4— 6 | 52 |
| 27 | Shale | 5 | 57 |
| " | "Slate" (shale), black | 3— 6 | 60— 6 |
| 26 | Summum (No. 4) coal | 1— 6 | 62 |
| 25 | "Fireclay" | 5 | 67 |
| 17 | Pleasantview sandstone | | |
| | Sandstone | 32— 6 | 99— 6 |
| | Clay shale | 4— 3 | 103— 9 |
| | Sandstone | 19 | 122— 9 |
| | Liverpool cyclothem | | |
| 5 | Clay shale (Francis Creek shale) | 26 | 148— 9 |
| 4 | LaSalle (No. 2) coal | 3 | 151— 9 |

[1]Authority William Campbell.

*40.—LaSalle County Carbon Coal Co. LaSalle shaft, NE. corner SE. ¼ SE. ¼ sec. 15, T. 33 N., R. 1 E. (LaSalle Twp.), LaSalle County, LaSalle quadrangle.*

Elevation 495 feet

| Unit No. | | Thickness Ft. In. | Depth Ft. In. |
|---|---|---|---|
| | Pennsylvanian system | | |
| | Undifferentiated | | |
| | Shale, blue | 6 | 6 |
| | Coal | 6 | 6— 6 |
| | Shale, brown | 8 | 14— 6 |
| | Limestone | 1— 6 | 16 |
| | Shale, blue | 12 | 28 |
| | Limestone, blue | 3— 2 | 31— 2 |
| | Shale, black | 5 | 31— 7 |
| | "Fireclay" | 1— 2 | 32— 9 |
| | Shale, black | 5 | 33— 2 |
| | Shale, brown | 3— 2 | 36— 4 |
| | Limestone | 3—10 | 40— 2 |
| | Shale, brown | 4— 6 | 44— 8 |
| | Shale, blue | 9— 4 | 54 |
| | Limestone, gray | 2— 4 | 56— 4 |
| | Shale, black | 1— 5 | 57— 9 |
| | Shale, blue | 10 | 67— 9 |
| | Limestone | 3— 3 | 71 |
| | Shale, blue | 10— 3 | 81— 3 |
| | Gimlet cyclothem | | |
| 64? | Limestone, black (Lonsdale?) | 2—10 | 84— 1 |
| 63 | Shale, blue | 6 | 90— 1 |
| " | Shale, with limestone nodules | 4— 6 | 94— 7 |
| " | Shale, blue | 10— 6 | 105— 1 |
| " | Shale, red | 6 | 111— 1 |
| " | Shale, blue | 1— 6 | 112— 7 |
| " | Shale, red | 14— 4 | 126—11 |
| " | Shale, blue | 11 | 137—11 |
| 62 | Sandstone | 6 | 143—11 |
| | Sparland cyclothem | | |
| 61 | Farmington shale, blue | 27 | 170—11 |
| " | "Slate" (shale), black | 4— 6 | 175— 5 |
| 60 | Sparland (No. 7) coal | 5 | 180— 5 |
| 59 | "Fireclay" | 6 | 186— 5 |
| " | Limestone | 4— 6 | 190—11 |
| " | Shale, blue | 10 | 200—11 |
| 58 | Copperas Creek sandstone | 10 | 210—11 |
| | Brereton cyclothem | | |
| 57 | Shale, blue | 14 | 224—11 |
| 54 | "Slate" (shale), black | 8 | 232—11 |
| 51 | Herrin (No. 6) coal | 6 | 238—11 |
| 50 | "Fireclay" | 1— 8 | 240— 7 |
| 49? | Limestone | 4— 6 | 245— 1 |
| | Brereton and St. David cyclothems | | |
| 40-41 | Shale, brown (Vermilionville sandstone and Canton shale) | 64 | 309— 1 |
| | St. David cyclothem | | |
| 39 | "Slate" (shale), black, mixed with coal | 3— 6 | 312— 7 |
| | Summum cyclothem | | |
| 28-29 | Limestone | 1 | 313— 7 |
| " | Shale, blue | 6 | 314— 1 |
| " | Limestone (Hanover?) | 3— 6 | 317— 7 |
| 27 | Shale, with limestone nodules | 2— 6 | 320— 1 |
| " | "Slate" (shale), black | 3— 4 | 323— 5 |
| 18-25 | Shale, with blue limestone nodules | 14 | 337— 5 |
| 17 | Sandstone | 8— 6 | 345—11 |
| | Liverpool cyclothem | | |
| 8 | Shale, blue | 18 | 363—11 |
| 6 | "Slate" (shale), black | 8 | 371—11 |
| 5 | Francis Creek shale | 14 | 385—11 |
| 4 | LaSalle (No. 2) coal | 4 | 389—11 |
| 3 | "Fireclay" | 8 | 397—11 |
| | Undifferentiated | | |
| | "Slate" (shale), and "fireclay" | 2 | 399—11 |
| | "Slate" (shale) | 5 | 404—11 |
| | "Black band" | 1 | 405—11 |
| | "Slate" (shale), blue | 1 | 406—11 |

*41.—LaSalle County Carbon Coal Co. boring No. 2, near NE. corner SE. ¼ NE. ¼ sec. 12, T. 32 N., R. 1 E. (Eden Twp.), LaSalle County, LaSalle quadrangle.*

Elevation 560 feet

| Unit No. | | Thickness Ft. In. | Depth Ft. In. |
|---|---|---|---|
| | Pleistocene system | | |
| | Soil, black | 1— 6 | 1— 6 |
| | Sand, yellow | 6— 6 | 8 |
| | Sand and gravel with water | 2 | 10 |

| Unit No. | | Thickness Ft. | In. | Depth Ft. | In. |
|---|---|---|---|---|---|
| | "Quicksand," white | 18 | | 28 | |
| | Clay, sandy (till?) | 5 | | 33 | |
| | Sand, white | 2 | | 35 | |
| | Clay, gray (till?) | 1 | | 36 | |
| | Pennsylvanian system | | | | |
| | Undifferentiated | | | | |
| | Limestone (LaSalle) | 7 | | 43 | |
| | "Fireclay" | 1 | | 44 | |
| | Limestone (LaSalle) | 15— | 6 | 59— | 6 |
| | "Slate" (shale), black | | 6 | 60 | |
| | Shale, dark gray | 4 | | 64 | |
| | Coal | | 4 | 64— | 4 |
| | "Fireclay" | 3— | 8 | 68 | |
| | Shale, dark gray | 5 | | 73 | |
| | Shale, dark and red | 4 | | 77 | |
| | Limestone | 2— | 6 | 79— | 6 |
| | Shale, gray | 9— | 6 | 89 | |
| | Limestone | 2 | | 91 | |
| | Shale, gray | 5 | | 96 | |
| | Clay, yellow | 2 | | 98 | |
| | Clay, red | 8— | 6 | 106— | 6 |
| | Shale, dark | 3— | 6 | 110 | |
| | Clay, red | 3 | | 113 | |
| | Limestone | 1 | | 114 | |
| | Shale, gray | 1 | | 115 | |
| | Limestone | 3 | | 118 | |
| | Shale, dark | 1 | | 119 | |
| | Clay, yellow | 4 | | 123 | |
| | Shale, blue | 4 | | 127 | |
| | Clay, dark gray | 4 | | 131 | |
| | Clay, red | 4 | | 135 | |
| | Shale, gray | 2 | | 137 | |
| | Limestone, gray | 1 | | 138 | |
| | Clay, dark | 1 | | 139 | |
| | "Slate" (shale), black | 1 | | 140 | |
| | Clay, dark | 5 | | 145 | |
| | Clay, yellow | 2 | | 147 | |
| | Clay, dark gray | 1 | | 148 | |
| | Limestone | | 6 | 148— | 6 |
| | Shale | 1— | 6 | 150 | |
| | Clay, red | 5 | | 155 | |
| | Clay, yellow | 2 | | 157 | |
| | Clay, blue | 1 | | 158 | |
| | Clay, gray | 1 | | 159 | |
| | Clay, red | 1 | | 160 | |
| | Limestone | 1 | | 161 | |
| | Clay, gray | 4 | | 165 | |
| | Clay, gray | 5 | | 170 | |
| | Gimlet cyclothem | | | | |
| 64 | Lonsdale limestone | | 6 | 170— | 6 |
| 63 | Clay, red | 8— | 6 | 179 | |
| " | Shale, gray | 7 | | 186 | |
| 62 | Shale, sandy | 2 | | 188 | |
| " | Limestone (sandstone?) | 3 | | 191 | |
| " | Shale, sandy | 11 | | 202 | |
| | Sparland cyclothem | | | | |
| 61 | Farmington shale | | | | |
| | Shale, gray | 12 | | 214 | |
| | Shale, dark | 11 | | 225 | |
| | "Slate" (shale), black | 6 | | 231 | |
| 60 | Sparland (No. 7) coal | 4 | | 235 | |
| 59 | "Fireclay" | 6 | | 241 | |
| " | Clay, gray | 5 | | 246 | |
| " | Clay, red | 2— | 6 | 248— | 6 |
| " | Shale, gray | 6 | | 254— | 6 |
| " | Shale, red | 3 | | 257— | 6 |
| " | Shale, gray | 1 | | 258— | 6 |
| " | Shale, gray and red | 1 | | 259— | 6 |
| 58 | Copperas Creek sandstone | | | | |
| | Shale, sandy | 22 | | 281— | 6 |
| | Sandstone | 5 | | 286— | 6 |
| | Brereton cyclothem | | | | |
| 54 | Shale, dark | 1— | 4 | 287— | 10 |
| 51 | Herrin (No. 6) coal | 3 | | 290— | 10 |
| 50 | "Fireclay" | 2— | 6 | 293— | 4 |
| 41 | Vermilionville sandstone | | | | |
| | Shale, gray | 29 | | 322— | 4 |
| | Shale, dark gray | 19 | | 341— | 4 |
| | Sandstone, dark | 5 | | 346— | 4 |
| | Shale, sandy, dark | 23 | | 369— | 4 |
| | Sandstone | 3 | | 372— | 4 |
| | St. David cyclothem | | | | |
| 40 | Canton shale | | | | |
| | Shale, dark | 2 | | 374— | 4 |
| | Limestone | | 8 | 375 | |
| | Shale, dark | 1— | 4 | 376— | 4 |
| 39 | "Slate" (shale), black | 3 | | 379— | 4 |
| | Summum cyclothem | | | | |
| 28? | Limestone (Hanover?) | 2 | | 381— | 4 |
| 27 | Shale, dark gray | 4 | | 385— | 4 |
| " | Shale, light blue | 4 | | 389— | 4 |
| " | Shale, dark gray | 3 | | 392— | 4 |
| " | "Slate" (shale), black | 5 | | 397— | 4 |
| 18-25 | Shale, dark gray | 3 | | 400— | 4 |
| " | Shale, light gray | 4 | | 404— | 4 |
| " | Shale, dark gray | 4 | | 408— | 4 |
| 17 | Pleasantview sandstone | | | | |
| | Shale, gray, sandy | 10 | | 418— | 4 |
| | Shale, sandy | 7 | | 425— | 4 |
| | Lowell cyclothem | | | | |
| 12-16 | Shale, dark sandy | 3 | | 428— | 4 |
| " | Shale, dark | 2— | 3 | 430— | 7 |
| 11 | Coal | | 3 | 430— | 10 |
| 10 | "Fireclay" | 1— | 6 | 432— | 4 |
| | Liverpool cyclothem | | | | |
| 8 | Shale, dark | 12 | | 444— | 4 |
| 6 | "Slate" (shale), black | 1 | | 445— | 4 |
| 5 | Francis Creek shale, gray | 15 | | 460— | 4 |
| 4 | LaSalle (No. 2) coal | 3— | 5 | 463— | 9 |
| 3 | "Fireclay" | 1— | 9 | 465— | 6 |
| | Shale, sandy | 5 | | 470— | 6 |
| | Undifferentiated | | | | |
| | Limestone | 1 | | 471— | 6 |
| | "Fireclay" | | | | |

*44.—St. Paul and Braceville Coal Co. boring, SE. ¼ SE. ¼ sec. 14, T. 31 N., R. 1 E. (Hope Twp.), LaSalle County, Wenona quadrangle.*

Elevation 690 feet

| Unit No. | | Thickness Ft. | Depth Ft. |
|---|---|---|---|
| | Pleistocene system | | |
| | Surface | 12 | 12 |
| | Clay, blue (till) | 63 | 75 |
| | Pennsylvanian system | | |
| | Undifferentiated | | |
| | Shale, blue | 19 | 94 |
| | Limestone | 1 | 95 |
| | Shale, blue | 38 | 133 |
| | Limestone | 1 | 134 |
| | Not recorded | 4 | 138 |
| | Shale, black | 5 | 143 |
| | Shale, blue | 38 | 181 |
| | Limestone (LaSalle) | 11 | 192 |
| | Shale, sandy | 104 | 296 |
| | Gimlet cyclothem | | |
| 62 | Sandstone | 2 | 298 |
| " | Shale, sandy | 37 | 335 |
| " | Conglomerate | 4 | 339 |

| Unit No. | | Thickness Ft. In. | Depth Ft. In. |
|---|---|---|---|
| | Sparland cyclothem | | |
| 61 | Farmington shale | | |
| | Shale, dark blue | 18 | 357 |
| | Shale, black | 3 | 360 |
| | Shale, dark blue | 4 | 364 |
| 60 | Sparland (No. 7) coal | | |
| | Coal | 2— 6 | 366— 6 |
| | "Sulphur" (pyrite?) | 1 | 366— 7 |
| | Coal | 9 | 367— 4 |
| 59 | Clay shale | 4— 8 | 372 |
| 59? | Shale, limy | 8 | 380 |
| 58 | Shale, sandy (Copperas Creek sandstone) | 26— 6 | 406— 6 |
| | Brereton cyclothem | | |
| 54 | Shale, black | 7— 3 | 413— 9 |
| 51 | Herrin (No. 6) coal | 3— 6 | 417— 3 |
| 50? | Clay shale | 9 | 418 |
| 41 | Vermilionville sandstone | | |
| | Shale, sandy | 25 | 443 |
| | Sandstone and shale | 18 | 461 |
| | Sandstone | 28 | 489 |
| | St. David cyclothem | | |
| 40 | Canton shale, blue | 5 | 494 |
| 39 | Shale, black | 1 | 495 |
| | Summum cyclothem | | |
| 28-29 | Shale, limy | 13 | 508 |
| 27 | Shale, black | 6 | 514 |
| 25 | Shale, limy | 5 | 519 |
| 17-24 | Shale, blue | 15 | 534 |
| | Lowell cyclothem | | |
| 12-16 | Shale, black | 5 | 539 |
| " | Shale, dark blue | 4 | 543 |
| " | Shale, black | 6 | 543— 6 |
| 11 | Coal | 8 | 544— 2 |
| | Liverpool cyclothem | | |
| 8 | Shale, sandy | 3—10 | 548 |
| " | Shale, dark blue | 11 | 559 |
| 6 | Shale, black | 1 | 560 |
| 5 | Francis Creek shale, blue | 22—11 | 582—11 |
| 4 | LaSalle (No. 2) coal | 2— 4 | 585— 3 |
| 3? | Clay-shale | 2— 6 | 587— 9 |
| | Undifferentiated | | |
| | Shale, limy | 23— 3 | 611 |
| | Shale, blue | 2 | 613 |

*47.—Mineral Point Zinc Co. boring No. 8,*[1] *NW. ¼ SE. ¼ sec. 14, T. 31 N., R. 1 W. (Magnolia Twp.), Putnam County.*

Elevation 665 feet

| Unit No. | | Thickness Ft. In. | Depth Ft. In. |
|---|---|---|---|
| | Pleistocene system | | |
| | Drift | 118 | 118 |
| | Pennsylvanian system | | |
| | Undifferentiated | | |
| | Shale, limy | 6 | 124 |
| | Limestone | 2 | 126 |
| | Shale, green | 3 | 129 |
| | Shale, black and blue | 2 | 131 |
| | Clay-shale | 5 | 136 |
| | Limestone, broken | 4 | 140 |
| | Clay-shale | 6 | 146 |
| | Limestone | 2 | 148 |
| | Shale, blue and red mixed | 3 | 151 |
| | Clay-shale | 5 | 156 |
| | Limestone | 3 | 159 |
| | Shale, blue and red | 12— 6 | 171— 6 |
| | Shale, black | 1 | 172— 6 |
| | Clay, shale | 2— 6 | 175 |
| | Limestone | 4— 6 | 179— 6 |
| | Shale, red | 7— 6 | 187 |
| | Gimlet cyclothem | | |
| 64 | Lonsdale limestone | 4 | 191 |
| 63 | Shale, red and gray | 15 | 206 |
| 62 | Shale, sandy, limy | 37 | 243 |
| " | Shale, limy | 6 | 249 |
| " | Shale, sandy, blue | 12 | 261 |
| " | Shale, sandy, blue | 19 | 280 |
| | Sparland cyclothem | | |
| 61 | Farmington shale, dark blue with brown bands | 6— 1 | 286— 1 |
| 60 | Sparland (No. 7) coal | 3— 7 | 289 |
| 59 | Clay-shale | 1— 4 | 291 |
| " | Shale, limy | 10 | 301 |
| " | Limestone | 3 | 304 |
| 58 | Shale, sandy, limy | 13 | 317 |
| | Brereton cyclothem | | |
| 57 | Shale, blue | 2— 6 | 319— 6 |
| 56 | Brereton limestone | 1 | 320— 6 |
| 54 | Shale, dark | 12— 8 | 333— 2 |
| 51 | Herrin (No. 6) coal | | |
| | Coal, bony | 4 | 333— 6 |
| | Coal | 2— 8 | 336— 2 |
| | Clay | 2 | 336— 4 |
| | Coal | 1— 1 | 337— 5 |
| 50 | Clay-shale | 2— 7 | 340 |
| 41 | Vermilionville sandstone | | |
| | Shale, sandy, limy | 4 | 344 |
| | Shale, blue | 4 | 348 |
| | Shale, sandy | 26 | 374 |
| | Sandstone, coal partings | 1 | 375 |
| | Shale, sandy | 10 | 385 |
| | St. David cyclothem | | |
| 40 | Canton shale | | |
| | Shale, blue | 7 | 392 |
| | Shale, black with brown bands | 6 | 398 |
| 39 | Shale, black | 3 | 401 |
| | Summum cyclothem | | |
| 29 | Shale, limy | 6 | 407 |
| 28 | Hanover limestone | 3 | 410 |
| 27 | Shale, mixed dark and green | 3 | 413 |
| " | Shale, dark | 3 | 416 |
| " | Shale, black | 3— 8 | 419— 8 |
| 26 | Summum (No. 4) coal, shaly | ½ | 419—8½ |
| 25 | Shale, limy | 2—3½ | 422 |
| " | Clay-shale | 2 | 424 |
| 17 | Pleasantview sandstone | | |
| | Shale, sandy, limy | 8 | 432 |
| | Shale, sandy | 11 | 443 |
| | Liverpool cyclothem | | |
| 5 | Francis Creek shale | | |
| | Shale, light blue | 4— 6 | 447— 6 |
| | Shale, dark blue with brown bands | 8— 6 | 456 |
| | Shale, blue with brown bands | 28 | 484 |
| | Shale, dark blue with brown bands | 12—11 | 496—11 |
| 4 | LaSalle (No. 2) coal | 3— 4 | 500— 3 |
| 3 | "Fireclay" | 9 | 501 |

[1]Authority Sullivan Machinery Co.

*48.—Cherry Option Syndicate boring No. 17,[1] M. L. Purdue farm, SW. ¼ SW. ¼ sec. 26, T. 31 N., R. 2 W. (Hennepin Twp.), Putnam County, Lacon quadrangle.*

Elevation—447.25 feet (leveled)

| *Unit No.* | | *Thickness* Ft. In. | *Depth* Ft. In. |
|---|---|---|---|
| | Pleistocene system | | |
| | Sand and gravel | 36 | 36 |
| | Pennsylvanian system | | |
| | Brereton cyclothem | | |
| 54 | "Slate" (shale), dark | 3 | 39 |
| 51 | Herrin (No. 6) coal, soft | 2— 6 | 41— 6 |
| 50 | "Fireclay" | 4— 6 | 46 |
| 41 | Vermilionville sandstone | | |
| | Sandstone | 25 | 71 |
| | Shale, sandy, dark | 43 | 114 |
| | St. David cyclothem | | |
| 40 | "Slate" (Canton shale), dark | 6— 4 | 120— 4 |
| 39 | "Slate" (shale), black | 2— 8 | 123 |
| | Summum cyclothem | | |
| 28-29 | Shale, light | 6 | 129 |
| " | Shale, limy | 3 | 132 |
| 27 | "Slate" (shale), black | 2 | 134 |
| | Summum and Lowell cyclothems | | |
| 11-25 | Shale, blue | 7 | 141 |
| " | Shale, limy | 3 | 144 |
| " | Shale, blue | 17 | 161 |
| " | Shale, gray | 26 | 187 |
| | Liverpool cyclothem | | |
| 8 | "Slate" (shale), dark | 9— 6 | 196— 6 |
| 6 | "Slate" (shale), black | 2— 6 | 199 |
| 5 | "Slate" (Francis Creek shale), blue | 16— 3 | 215— 3 |
| 4 | LaSalle (No. 2) coal | 2—10 | 218— 1 |
| 3 | "Fireclay" | 11 | 219 |

[1]Authority F. W. Cherry.

*49.—Wenona Coal Co. shaft and boring,[1] NE. ¼ NE. ¼ sec. 24, T. 30 N., R. 1 E. (Evans Twp.), Marshall County, Wenona quadrangle.*

Elevation 695 feet

| *Unit No.* | | *Thickness* Ft. In. | *Depth* Ft. In. |
|---|---|---|---|
| | Pleistocene system | | |
| | Soil and yellow clay | 10 | 10 |
| | Clay, blue (till) | 46 | 56 |
| | Sand | 10 | 66 |
| | "Hardpan" (till) | 34 | 100 |
| | Pennsylvanian system | | |
| | Undifferentiated | | |
| | Clay, red | 3 | 103 |
| | Clay-shale, soft | 3 | 106 |
| | Limestone, hard | 1— 6 | 107— 6 |
| | Shale, brown | 6 | 113— 6 |
| | Sandstone | 7 | 120— 6 |
| | Shale, blue | 13 | 133— 6 |
| | Clay-shale, dark | 4 | 137— 6 |
| | Limestone (LaSalle) | 13 | 150— 6 |
| | "Slate" (shale), gray | 3— 6 | 154 |
| | "Slate" (shale), black | 3 | 157 |
| | Coal, poor | 6 | 157— 6 |
| | "Slate" (shale), gray | 11 | 168— 6 |
| | Shale, blue | 2 | 170 |
| | Limestone, top hard | 11 | 181— 6 |
| | Shale, brown | 8 | 189— 6 |
| | Clay-shale | 6 | 195— 6 |
| | Sandstone, hard | 2 | 197— 6 |
| | Gimlet cyclothem | | |
| | Clay-shale | 4 | 201— 6 |
| | Shale, brown | 2 | 203— 6 |
| | Shale, blue | 6 | 209— 6 |
| 64 | Lonsdale limestone, hard | 2 | 211— 6 |
| 63 | Shale, blue | 4 | 215— 6 |
| " | Clay-shale, gray | 17 | 232— 6 |
| " | Shale, blue | 5 | 237— 6 |
| " | Shale, brown | 14 | 251— 6 |
| 62 | Sandstone, blue | 30 | 281— 6 |
| | Sparland cyclothem | | |
| 61 | Farmington shale | | |
| | "Slate" (shale), gray | 14 | 295— 6 |
| | Shale, dark | 38 | 333— 6 |
| 60 | Sparland (No. 7) coal | 3— 4 | 336—10 |
| 59 | "Fireclay" | 10 | 346—10 |
| 58 | Shale, sandy | 8 | 354—10 |
| | Brereton cyclothem | | |
| 57 | Clay-shale | 18 | 372—10 |
| " | Shale, black | 3 | 375—10 |
| " | Shale, dark | 2 | 377—10 |
| " | Shale, brown | 3 | 380—10 |
| 56 | "Flint rock?" | 4 | 384—10 |
| 54 | "Slate" (shale), dark | 4 | 388—10 |
| 50 | "Fireclay," nodular | 2—10 | 391— 8 |
| " | Shale, brown | 4 | 392 |
| " | "Fireclay" | 4— 8 | 396— 8 |
| 41 | Vermilionville sandstone | | |
| | Shale, sandy | 3— 6 | 400— 2 |
| | Clay-shale, soft | 1— 8 | 401—10 |
| | Sandstone | 15— 6 | 417— 4 |
| | St. David cyclothem | | |
| 40 | Canton shale | | |
| | "Slate" (shale), gray | 5— 8 | 423 |
| | "Slate" (shale), dark, with "iron" bands | 1— 6 | 424— 6 |
| | "Slate" (shale), gray, with "sulphur" balls | 21— 6 | 446 |
| | "Slate" (shale), black, with fossil shells | 4 | 450 |
| | Shale, gray, with shells and plants | 15— 8 | 465— 8 |
| 39 | "Slate" (shale), black | 3— 6 | 469— 2 |
| | Summum cyclothem | | |
| 29 | Clay-shale, blue | 6 | 475— 2 |
| 28 | Hanover limestone; in two bands separated by 3 inches shale | 1— 1 | 476— 3 |
| 27 | Shale, dark | 4 | 480— 3 |
| " | Limestone | 1 | 481— 3 |
| " | Clay-shale, dark | 2— 6 | 483— 9 |
| " | "Slate" (shale), black | 5 | 488— 9 |
| 26 | Summum (No. 4) coal; upper 5 inches cannel | 1— 2 | 489—11 |
| 25 | "Fireclay" | 6 | 495—11 |
| 23 | Limestone | 1 | 496—11 |
| 22 | Clay-shale, dark | 2— 6 | 499— 5 |
| 19-21 | "Slate" (shale), black | 5 | 504— 5 |
| " | Coal | 1— 2 | 505— 7 |
| 18 | "Fireclay" | 6— 5 | 512 |
| 17? | Limestone (Pleasantview sandstone?) | 2 | 514 |
| | Lowell cyclothem | | |
| 12-16 | Clay-shale, light and dark | 22— 2 | 536— 2 |
| 10 | Coal, poor | 4 | 536— 6 |
| 9 | Sandstone, with sulphur (pyrite?) and 1 inch coal | 4— 6 | 541 |

| Unit No. | | Thickness Ft. In. | Depth Ft. In. |
|---|---|---|---|
| | Liverpool cyclothem | | |
| 8 | Clay-shale, dark | 13 | 554 |
| 7 | "Sulphur rock" (limestone?), hard | 3— 6 | 557— 6 |
| 6 | "Slate" (shale), black | 4— 6 | 562 |
| 5 | Francis Creek shale | | |
| | "Slate" (shale), gray | 11— 8 | 573— 8 |
| 4 | LaSalle (No. 2) coal | 2— 8 | 576— 4 |
| 3 | "Fireclay" | 3— 9 | 580— 1 |
| | Sandstone | 9— 9 | 589—10 |
| | Undifferentiated | | |
| | "Slate" (shale), gray | 2 | 591—10 |
| | Shale, dark | 5 | 596—10 |
| | "Rock," hard | 1— 5 | 598— 3 |
| | Coal | 1 | 599— 3 |
| | "Fireclay" | 5— 9 | 605 |
| | "Slate" (shale), dark | 1— 9 | 606— 9 |
| | Shale, dark | 2 | 608— 9 |
| | "Rock," hard | 7 | 609— 4 |
| | "Slate" (shale), gray | 1— 6 | 610—10 |
| | Shale | 4 | 611— 2 |
| | Rock | 1— 4 | 612— 6 |
| | Shale | 2— 8 | 615— 2 |
| | Coal | 11 | 616— 1 |
| | "Fireclay" | 5— 4 | 621— 5 |
| | Shale and "hard band" | 9— 7 | 631 |
| | Shale, gray | 4 | 631— 4 |
| | Coal | 1— 1 | 632— 5 |
| | Clay | 1— 6 | 633—11 |
| | Coal | 1— 2 | 635— 1 |
| | Ordovician system | | |
| | Limestone with artesian water | 1 | 636— 1 |

[1]Authority for shaft (upper 576 ft.) A. H. Worthen, Geology and Paleontology, Geological Survey of Illinois, vol. 7, pp. 29-30, 1883, record of boring (below 576 ft.) from Wenona Coal Company.

*50.—Cherry Option Syndicate boring No. 6,*[1] *John Jesse farm, SW. ¼ NE. ¼ sec. 9, T. 30 N., R. 1 W. (Roberts Twp.), Marshall County, Wenona quadrangle.*

Elevation 549.7 feet (leveled)

| Unit No. | | Thickness Ft. In. | Depth Ft. In. |
|---|---|---|---|
| | Pleistocene system | | |
| | Sand and gravel (?) | 143 | 143 |
| | Pennsylvanian system | | |
| | Brereton cyclothem | | |
| 41 | Vermilionville sandstone | | |
| | Sandstone, blue | 24 | 167 |
| | Shale, dark | 3 | 170 |
| | Sandstone, blue | 17 | 187 |
| | Shale, dark | 6 | 193 |
| | Sandstone | 9 | 202 |
| | St. David cyclothem | | |
| 40 | "Slate" (shale), dark (Canton) | 5 | 207 |
| 39 | "Slate" (shale), black | 1— 6 | 208— 6 |
| | Summum cyclothem | | |
| 29 | Shale, light | 2 | 210— 6 |
| 28 | Hanover limestone | 6 | 211 |
| 27 | Shale, blue | 8— 6 | 219— 6 |
| " | "Slate" (shale), black | 2— 6 | 222 |
| 25 | "Fireclay" | 3 | 225 |
| | Summum and Lowell cyclothems | | |
| 12-24 | Shale, blue | 29— 6 | 254— 6 |
| | Lowell cyclothem | | |
| 11 | "Slate" (shale), black | 1— 6 | 256 |
| | Liverpool cyclothem | | |
| 8 | Shale, dark | 8 | 264 |
| 5 | Francis Creek shale | | |
| | Shale, blue | 37— 8 | 301— 8 |
| | "Slate" (shale), blue | 1— 6 | 303— 2 |
| 4 | LaSalle (No. 2) coal, "slaty" (shaly) | 2— 7 | 305— 9 |
| 3 | "Fireclay" | 4 | 309— 9 |
| | Undifferentiated | | |
| | Shale, blue | 18— 3 | 328 |
| | Shale, dark | 17 | 345 |
| | Shale, limy | 2 | 347 |
| | Shale, blue and dark | 15 | 362 |
| | "Fireclay" | 3 | 365 |
| | Shale, blue | 18 | 383 |
| | Shale, dark | 4 | 387 |
| | Shale, blue and dark | 9— 3 | 396— 3 |
| | Coal | 5 | 396— 8 |
| | "Fireclay" | 1— 4 | 398 |

[1]Authority F. W. Cherry.

*51.—Cherry Option Syndicate boring No. 2,*[1] *Paul Winder farm, NW. ¼ NE. ¼ sec. 18, T. 30 N., R. 2 W. (Hopewell Twp.), Marshall County, Lacon quadrangle.*

Elevation 458.4 feet (leveled)

| Unit No. | | Thickness Ft. In. | Depth Ft. In. |
|---|---|---|---|
| | Pleistocene system | | |
| | Sand and soil | 38 | 38 |
| | Sand, fine | 32 | 70 |
| | Gravel | 3 | 73 |
| | Pennsylvanian system | | |
| | Brereton cyclothem | | |
| 55? | Shale, light | 9 | 82 |
| 54? | "Slate" (shale), black | 2 | 84 |
| | Brereton and St. David cyclothems | | |
| 40-41? | Shale, light blue | 62— 6 | 146— 6 |
| | St. David cyclothem | | |
| 40 | Canton shale | | |
| | Limestone | 6 | 147 |
| | "Slate" (shale), dark | 8— 6 | 155— 6 |
| 39 | "Slate" (shale), black | 2— 6 | 158 |
| | Summum cyclothem | | |
| 29 | "Fireclay" | 3 | 161 |
| 27 | "Slate" (shale), light | 7— 5 | 168— 5 |
| 26 | Summum (No. 4) coal | | |
| | Coal | 1— 2 | 169— 7 |
| | "Sulphur" | 1 | 169— 8 |
| | Coal | 1— 8 | 171— 4 |
| 25 | "Fireclay" | 4 | 175— 4 |
| 18-24? | Shale, blue | 25— 8 | 201 |
| 17 | Pleasantview sandstone | | |
| | Shale, sandy | 9 | 210 |
| | Sandstone | 23 | 233 |
| | Lowell cyclothem | | |
| 11 | "Slate" (shale), black | 6 | 233— 6 |
| 10 | "Fireclay" | 2 | 235— 6 |
| | Liverpool cyclothem | | |
| 8 | Shale, light | 15— 6 | 251 |
| 6 | "Slate" (shale), black | 8 | 251— 8 |
| 4 | LaSalle (No. 2) coal | 10 | 252— 6 |
| 3 | "Fireclay" | 1— 6 | 254 |
| | Undifferentiated | | |
| | Shale, light | 5 | 259 |
| | "Slate" (shale), dark | 6— 6 | 265 — 6 |
| | "Slate" (shale), black | 6 | 266 |
| | "Fireclay" | 3 | 269 |
| | Shale, sandy | 2 | 271 |

| Unit No. | | Thickness Ft. In. | Depth Ft. In. |
|---|---|---|---|
| | Sandstone | 8 | 279 |
| | Shale, brown | 36 | 315 |
| | Limestone and shale | 2 | 317 |
| | Shale, brown | 20 | 337 |
| | Shale, blue | 5 | 342 |
| | Shale, dark | 4 | 346 |
| | Shale, blue | 1 | 347 |
| | Limestone, gray, hard | 11 | 358 |
| | Limestone, soft | 19 | 377 |
| | Shale, light | 1— 6 | 378— 6 |
| | Limestone, hard | 1— 6 | 380 |

[1]Authority F. W. Cherry.

*52.—Barr Coal, Lumber and Power Co. boring No. 2.[1] E. R. and J. F. Fairbanks farm, SW. ¼ NW. ¼ sec. 34, T. 12 N., R. 9 E. (Steuben Twp.), Marshall County, Metamora quadrangle.*

Elevation 680 feet

| Unit No. | | Thickness Ft. In. | Depth Ft. In. |
|---|---|---|---|
| | Pleistocene system | | |
| | Clay (till?) | 17 | 17 |
| | Gravel and sand, drift (till?) | 51— 4 | 68— 4 |
| | Gravel | 4 | 72— 4 |
| | Drift, blue | 3 | 75— 4 |
| | Sand and gravel | 5 | 80— 4 |
| | Pennsylvanian system | | |
| | Gimlet cyclothem | | |
| 62-63? | Shale, light gray | 23— 4 | 103— 8 |
| 62 | Sandstone | 1— 3 | 104—11 |
| | Sparland cyclothem | | |
| 61 | Farmington shale | | |
| | Shale, light gray | 2— 3 | 107— 2 |
| | Shale, dark gray | 15— 1 | 122— 3 |
| | Sandstone | 2 | 124— 3 |
| | Shale, dark gray | 21— 7 | 145—10 |
| | Shale, black | 2— 4 | 148— 2 |
| 60 | Sparland (No. 7) coal, soft, dirty | 2— 6 | 150— 8 |
| 59 | "Fireclay" | 2— 9 | 153— 5 |
| " | Shale, limy | 2—10 | 156— 3 |
| 58 | Copperas Creek sandstone | 7— 1 | 163— 4 |
| | Brereton cyclothem | | |
| 57 | Shale, limy, sandy | 9 | 172— 4 |
| 54 | Shale, dark | 8 | 173 |
| 51 | Herrin (No. 6) coal | | |
| | Coal | 2— 4 | 175— 4 |
| | "Fireclay" | 4 | 175— 8 |
| | Coal | 11 | 176— 7 |
| 50 | "Fireclay" | 2 | 178— 7 |
| | Shale, light | 14— 2 | 192— 9 |
| 41 | Vermilionville sandstone | | |
| | Shale, sandy, gray | 14 | 206— 9 |
| | Shale, sandy, light | 3— 2 | 210—11 |
| | St. David cyclothem | | |
| 40 | Canton shale | | |
| | Shale, dark gray | 33— 1 | 244 |
| | Shale, gray | 6 | 244— 6 |
| | Shale, black | 2 | 246— 6 |
| 39 | "Slate" (shale), black | 2— 9 | 249— 3 |
| | Springfield (No. 5) coal | 5 | 249— 8 |
| | "Fireclay" | 1— 6 | 251— 2 |
| | Summum cyclothem | | |
| 27-29 | Shale, light | 3— 1 | 254— 3 |
| 27 | Shale, dark | 2— 6 | 256— 9 |
| 27? | Shale, light | 5 | 261— 9 |
| 17 | Pleasantview sandstone | | |
| | Sandstone | 1— 6 | 263— 3 |
| | Shale, light gray | 8—10 | 272— 1 |
| | Sandstone | 9 | 281— 1 |
| | Shale, light gray | 1— 2 | 282— 3 |
| | Sandstone | 3— 1 | 285— 4 |
| | Lowell cyclothem | | |
| 12-16 | Shale, light | 10— 8 | 296 |
| 9 | Sandstone | 3 | 299 |
| | Liverpool cyclothem | | |
| 8 | Shale, sandy, gray | 4— 2 | 303— 2 |
| 5 | Francis Creek shale | | |
| | Shale, gray | 13 | 316— 2 |
| | Shale, light gray | 28 | 344— 2 |
| | Shale, blue | 10 | 354— 2 |
| | Shale, light gray | 6—10 | 361 |
| 4 | LaSalle (No. 2) coal | 2— 4 | 363— 4 |
| | Undifferentiated | | |
| | Shale, light gray | 12— 8 | 375 |
| | Shale, light | 21 | 396 |

[1]Authority J. I. Thompson.

*53.—Delvin Coal Co. boring No. 2,[1] Erie farm, NE. ¼ NE. ¼ NE. ¼ sec. 5, T. 29 N., R. 1 E. (Bennington Twp.), Marshall County, Wenona quadrangle.*

Elevation 700 feet

| Unit No. | | Thickness Ft. In. | Depth Ft. In. |
|---|---|---|---|
| | Pleistocene system | | |
| | Soil | 1 | 1 |
| | Clay, brown | 5 | 6 |
| | Clay, gray (till) | 38 | 44 |
| | Sand, water-bearing | 7 | 51 |
| | Gravel, water-bearing | 5 | 56 |
| | Gravel and sand | 3 | 59 |
| | Clay, gray | 3 | 62 |
| | Gravel and clay | 5 | 67 |
| | Gravel and sand | 12 | 79 |
| | Gravel and clay | 12 | 91 |
| | Sand and gravel | 8 | 99 |
| | Gravel and clay | 15 | 114 |
| | Pennsylvanian system | | |
| | Undifferentiated | | |
| | Shale, gray | 16 | 130 |
| | Limestone | 5 | 135 |
| | Clay, red | 3 | 138 |
| | Shale, dark | 4 | 142 |
| | "Fireclay" | 3 | 145 |
| | Clay, red | 3 | 148 |
| | Clay, gray | 2 | 150 |
| | Clay, dark | 3 | 153 |
| | "Fireclay" | 4 | 157 |
| | Shale, dark | 2 | 159 |
| | Shale, light | 6 | 165 |
| | Clay, gray | 2 | 167 |
| | Shale, light | 4 | 171 |
| | Shale, gray | 5 | 176 |
| | Shale, dark | 2 | 178 |
| | "Fireclay" | 1— 6 | 179— 6 |
| | "Fireclay" and shale | 9— 6 | 189 |
| | Gimlet cyclothem | | |
| 62 | Sandstone | 49 | 238 |
| " | Shale, sandy | 15 | 253 |
| | Sparland cyclothem | | |
| 61 | Farmington shale | | |
| | Shale, dark | 25 | 278 |
| | "Slate" (shale), black | 6 | 278— 6 |
| | Shale, dark | 9— 6 | 288 |
| 60 | Sparland (No. 7) coal | 3— 6 | 291— 6 |
| 59 | Clay | 7— 6 | 299 |
| 58 | Copperas Creek sandstone | 14 | 313 |

| Unit No. | | Thickness Ft. | Thickness In. | Depth Ft. | Depth In. |
|---|---|---|---|---|---|
| | Brereton cyclothem | | | | |
| 57 | Shale | 5 | | 318 | |
| 56 | Limestone | 3 | | 321 | |
| 54 | "Slate" (shale), black | 10 | | 331 | |
| 51 | Herrin (No. 6) coal | 1 | 6 | 332 | 6 |
| 50 | "Fireclay" | 5 | 6 | 338 | |
| 41 | Vermilionville sandstone | | | | |
| | Sandstone | 8 | | 346 | |
| | Shale, sandy | 49 | | 395 | |
| | St. David cyclothem | | | | |
| 40 | Canton shale, dark | 6 | | 401 | |
| 39 | "Slate" (shale), black | 3 | 6 | 404 | 6 |
| | Summum cyclothem | | | | |
| 28 | Hanover limestone | 3 | 6 | 408 | |
| 27 | Shale, dark | 16 | | 424 | |
| " | Shale, black | 4 | | 428 | |
| 26 | Summum (No. 4) coal | 1 | | 429 | |
| 25 | "Fireclay" | 6 | | 435 | |
| 17 | Shale, sandy (Pleasantview sandstone) | 16 | | 451 | |
| | Lowell cyclothem | | | | |
| 12-16 | Shale, gray | 2 | | 453 | |
| " | Shale, dark | 3 | | 456 | |
| | Liverpool cyclothem | | | | |
| 8? | Sandstone (sandy shale?) | 13 | | 469 | |
| 5 | Francis Creek shale | 35 | | 504 | |
| 4 | LaSalle (No. 2) coal | 2 | 6 | 506 | 6 |
| 3 | "Fireclay" | | 6 | 507 | |

[1]Authority Toluca Coal Co.

*54.—Shaft and boring at Minonk,*[1] *SE. ¼ SE. ¼ NW. ¼ SE. ¼ sec. 7, T. 28 N., R. 2 E. (Minonk Twp.), Woodford County.*

Elevation 750 feet

| Unit No. | | Thickness Ft. | Thickness In. | Depth Ft. | Depth In. |
|---|---|---|---|---|---|
| | Pleistocene system | | | | |
| | Soil | 2 | | 2 | |
| | Clay, yellow (till) | 14 | | 16 | |
| | Clay, blue (till) | 18 | | 34 | |
| | Sand and gravel | 15 | | 49 | |
| | Sand and gravel, cemented | 76 | | 125 | |
| | Pennsylvanian system | | | | |
| | Undifferentiated | | | | |
| | Limestone | 6 | | 131 | |
| | Clay-shale | 3 | | 134 | |
| | "Slate" (shale), black | 1 | | 135 | |
| | Clay-shale, blue | 7 | | 142 | |
| | Clay-shale, red | 3 | | 145 | |
| | Limestone | 1 | | 146 | |
| | Clay-shale | 18 | | 164 | |
| | Limestone | 1 | | 165 | |
| | Sandstone | 14 | | 179 | |
| | Clay-shale | 10 | | 189 | |
| | Shale, sandy | 7 | | 196 | |
| | Gimlet cyclothem | | | | |
| | "Slate" (shale), black | 3 | | 199 | |
| | Clay-shale, blue | 9 | | 208 | |
| 63 | Clay-shale, red | 13 | | 221 | |
| 62 | Sandstone | 100 | | 321 | |
| | Sparland cyclothem | | | | |
| 61 | "Slate" (shale), black | 3 | | 324 | |
| " | Clay-shale | 2 | | 326 | |
| 60 | Sparland (No. 7) coal | 3 | | 329 | |
| 59 | Clay | 12 | | 341 | |
| 58 | Shale, sandy (Copperas Creek sandstone) | 6 | | 347 | |
| | Brereton cyclothem | | | | |
| 56 | Brereton limestone, argillaceous | 2 | | 349 | |
| 52 | Shale, sandy | 30 | | 379 | |
| 51 | Herrin (No. 6) coal | | 2 | 379 | 2 |
| 50 | Clay | 6 | | 385 | 2 |
| 41 | Shale, sandy (Vermilionville sandstone) | 33 | | 418 | 2 |
| | St. David cyclothem | | | | |
| | Canton shale | | | | |
| 40? | "Slate" (shale), black | 19 | | 437 | 2 |
| | Sandstone (shale?) | 12 | | 449 | 2 |
| | Limestone | 2 | | 451 | 2 |
| | Clay-shale | 18 | | 469 | 2 |
| | Summum cyclothem? | | | | |
| 28? | Limestone (Hanover?) | 2 | | 471 | 2 |
| 27? | Sandstone | 6 | | 477 | 2 |
| 18-25? | Clay-shale | 18 | | 495 | 2 |
| 17 | "Chert" (Pleasantview sandstone?) | | 9 | 495 | 11 |
| | Lowell cyclothem | | | | |
| 12-16 | Clay-shale | 18 | | 513 | 11 |
| 11 | "Slate" (shale), black | 2 | | 515 | 11 |
| | Liverpool cyclothem | | | | |
| 8 | Clay-shale | 14 | | 529 | 11 |
| 7? | "Sulphur rock" (limestone?) | 1 | | 530 | 11 |
| 6 | "Slate" (shale), black | 5 | | 535 | 11 |
| 5 | Clay-shale on black "slate" (Francis Creek shale) | 7 | | 542 | 11 |
| 4 | LaSalle (No. 2) coal | 3 | 10 | 546 | 9 |

[1]Authority Green, H. A., Geology and Paleontology, Woodford County, Geological Survey of Illinois, vol. 4, pp. 336, 338-340, 1870.

## APPENDIX C—
## RECORDS OF DEEP WELLS

Compiled by
J. Norman Payne

Numbers refer to numbers appearing on maps (pls. 13-27). Records compiled mostly from study of well cuttings. Driller's record, where used, is indicated by the use of quotation marks around the description of materials.

The name of the drilling contractor is given first, followed by the farm name and number.

*Well No. 1.—B. L. Palmer and Son—Oswego Village No. 2, NW. ¼ SE. ¼ SW. ¼ sec. 17, T. 37 N., R. 8 E. (Oswego Twp.), Kendall County, Yorkville quadrangle.*

Elevation 653 feet

| | Thickness Ft. | Depth Ft. |
|---|---|---|
| Pleistocene system (details omitted) | 24 | 24 |
| Silurian system | | |
| Alexandrian series | | |
| "Limestone" (no samples) | 21 | 45 |
| Ordovician system | | |
| Cincinnatian series | | |
| Maquoketa formation | | |
| "Shale" (no samples) | 147 | 192 |
| Mohawkian series | | |
| Galena-Platteville formations | | |
| Limestone, buff, finely to coarsely granular | 203 | 395 |
| Dolomite, buff, finely crystalline, cherty in top part | 25 | 420 |
| "Limestone" (no samples) | 10 | 430 |
| Limestone, dolomitic, buff, finely granular | 5 | 435 |
| Dolomite, buff to gray, very finely crystalline | 20 | 455 |
| Limestone, brown, dark gray spots, lithographic to very fine; some interbedded dolomite, and thin shale partings | 35 | 490 |
| "Limestone" (no samples) | 15 | 505 |
| Dolomite, brownish-gray, very finely crystalline | 35 | 540 |
| Glenwood formation | | |
| Sandstone, dolomitic, light gray, coarse-grained | 10 | 550 |
| Chazyan series | | |
| St. Peter sandstone | | |
| Sandstone, white, medium-grained | 10 | 560 |
| Sandstone, white, fine-grained | 160 | 720 |

*Well No. 4.—Joseph Egerer—Sandwich City No. 2, NW. ¼ NE. ¼ NW. ¼ sec. 36, T. 37 N., R. 5 E. (Sandwich Twp.), Dekalb County, Plano quadrangle.*

Elevation 667 feet

| | Thickness Ft. | Depth Ft. |
|---|---|---|
| Pleistocene system (details omitted) | 130 | 130 |
| Cambrian system | | |
| St. Croixan series | | |
| Trempealeau formation | | |
| Dolomite, partly sandy, buff, gray, and purple, glauconitic | 10 | 140 |
| "Lime, shelly" (no samples) | 5 | 145 |
| Dolomite, light gray, slightly glauconitic | 20 | 165 |
| Dolomite, sandy, greenish-gray, and sandstone, dolomitic, gray | 5 | 170 |
| "Lime" (no sample) | 5 | 175 |
| Dolomite, gray, partly sandy | 10 | 185 |
| Dolomite, pinkish-buff, glauconitic, sandy in lower part | 50 | 235 |
| Dolomite, pinkish-buff, red spots | 20 | 255 |
| Same, but glauconitic | 15 | 270 |
| Franconia formation | | |
| Dolomite, sandy, greenish-gray, pink, and red, glauconitic, and sandstone, dolomitic and glauconitic | 35 | 305 |
| Sandstone, dolomitic, greenish-gray, glauconitic, and shale, green, and dolomite, greenish-gray | 15 | 320 |
| Sandstone, dolomitic, green to gray, glauconitic, and shale, silty, green | 35 | 355 |
| Same, interbedded with dolomite | 45 | 400 |
| Dresbach group | | |
| Galesville formation | | |
| Sandstone, dolomitic, buff, fine- to coarse-grained; dolomite, sandy, light buff | 20 | 420 |
| Sandstone, partly dolomitic, light buff, fine- to coarse-grained | 65 | 485 |
| Sandstone, light buff, fine- to coarse-grained | 100 | 585 |
| Eau Claire formation | | |
| Shale, sandy, bright green and brown; dolomite, sandy, brownish-gray; and sandstone, dolomitic, gray, very fine-grained | 15 | 600 |

*Well No. 7.—Amboy Oil and Gas Company—McElroy No. 1, SW. ¼ SW. ¼ NW. ¼ sec. 30, T. 20 N., R. 10 E. (Amboy Twp.), Lee County, Amboy quadrangle.*

Elevation 714 feet

| | *Thickness Ft.* | *Depth Ft.* |
|---|---|---|
| No record | 480 | 480 |
| Ordovician system | | |
| Mohawkian series | | |
| Galena formation | | |
| Dolomite, light brown to gray, medium crystalline | 80 | 560 |
| Decorah formation | | |
| Dolomite, slightly cherty, brownish-gray, finely crystalline | 30 | 590 |
| Platteville formation | | |
| Dolomite, light gray to light brownish-gray, finely to medium crystalline, mostly very finely crystalline | 40 | 630 |
| No record | 10 | 640 |
| Dolomite, brownish-gray, with dark gray spots and shale, dolomitic, dark brown | 10 | 650 |
| Dolomite, sandy, brownish-gray | 20 | 670 |
| Glenwood formation | | |
| Sandstone, white, fine- and coarse-grained | 15 | 685 |
| Sandstone, white, medium-grained | 30 | 715 |
| Sandstone, dolomitic, white, very fine- and coarse-grained | 5 | 720 |
| Dolomite, sandy, green; sandstone, white, coarse-grained | 15 | 735 |
| Chazyan series | | |
| St. Peter sandstone | | |
| Sandstone, white, medium- to coarse-grained | 40 | 775 |
| Sandstone, yellow and pink, fine- to medium-grained | 25 | 800 |
| Sandstone, white, medium- to coarse-grained, conglomeratic, with chert pebbles | 25 | 825 |
| Sandstone, white, medium-grained | 20 | 845 |
| Same, with chert and dolomite pebbles; and some shale, white | 10 | 855 |
| Shale, red and blue | 10 | 865 |
| Sandstone, white, with chert and dolomite pebbles | 5 | 870 |
| Prairie du Chien series | | |
| Shakopee formation | | |
| Dolomite, light gray and pink, finely crystalline | 10 | 880 |
| Same, but sandy and cherty | 15 | 895 |
| New Richmond formation | | |
| Sandstone, white, medium- to coarse-grained | 20 | 915 |
| Same, and dolomite, cherty, light gray | 5 | 920 |
| Dolomite, cherty, white | 10 | 930 |
| Sandstone, white, coarse-grained | 10 | 940 |
| Same, cherty; shale, red and blue | 10 | 950 |
| No record | 10 | 960 |
| Shale, light blue-gray | 10 | 970 |
| Oneota formation | | |
| Dolomite, cherty, white to light gray, finely crystalline | 105 | 1075 |
| Dolomite, pinkish-gray, very finely to coarsely crystalline, cherty at base | 40 | 1115 |
| Dolomite, cherty, buff to brown | 30 | 1145 |
| Cambrian system | | |
| St. Croixan series | | |
| Jordan formation | | |
| Dolomite, sandy, cherty, light gray to pink | 10 | 1155 |
| Same; sandstone, white, medium-grained; shale, red and blue | 5 | 1160 |
| Trempealeau formation | | |
| Dolomite, pink to gray, very finely crystalline | 15 | 1175 |
| Dolomite, sandy, cherty, pink | 20 | 1195 |
| Sandstone, dolomitic, cherty, white, fine-grained | 5 | 1200 |
| Dolomite, sandy, pink, very finely crystalline | 55 | 1255 |
| No record | 5 | 1260 |
| Dolomite, pink, very finely crystalline | 5 | 1265 |
| Dolomite, light gray to pink, slightly glauconitic | 90 | 1355 |
| Franconia formation | | |
| Dolomite, sandy, red, glauconitic | 10 | 1365 |
| Sandstone, dolomitic, red, fine-grained, glauconitic | 10 | 1375 |
| Dolomite, green, glauconitic | 5 | 1380 |
| Sandstone, dolomitic, green to brownish-gray, very fine-grained, glauconitic | 50 | 1430 |
| No record | 5 | 1435 |
| Dolomite, sandy, argillaceous, brown, glauconitic; shale, dolomitic, sandy, green | 20 | 1455 |
| Dresbach group | | |
| Galesville sandstone | | |
| Sandstone, dolomitic, light buff, fine- to coarse-grained | 165 | 1620 |
| Eau Claire formation | | |
| No record | 5 | 1625 |
| Sandstone, dolomitic, brown, fine-grained | 10 | 1635 |
| No record | 5 | 1640 |
| Sandstone, dolomitic, light buff, very fine-grained, glauconitic; shale, dark gray, fossiliferous | 35 | 1675 |
| Sandstone, dolomitic, red to buff, fine-grained, glauconitic; some beds of siltstone, pink and some | | |

| | Thickness Ft. | Depth Ft. |
|---|---|---|
| shale, red to greenish-gray | 110 | 1785 |
| Sandstone, as above; dolomite, sandy, pink, glauconitic; shale, red | 5 | 1790 |
| Sandstone, dolomitic, pink to white, coarse-grained, glauconitic, conglomeratic | 5 | 1795 |
| Sandstone, dolomitic, light pink to light gray, fine- to medium-grained | 25 | 1820 |
| Dolomite, sandy, brown, grading down to sandstone, dolomitic, light gray | 25 | 1845 |
| Siltstone, sandy, dolomitic, brownish-gray, grading down to sandstone | 20 | 1865 |
| Dolomite, sandy, brownish-gray | 5 | 1870 |
| Sandstone, white to yellow, fine- to medium-grained | 95 | 1965 |
| Sandstone, dark to light gray, fine- to coarse-grained, grains covered with finely divided pyrite | 35 | 2000 |
| Sandstone, white, medium- to coarse-grained | 40 | 2040 |
| Sandstone, gray, medium- to coarse-grained, pyrite coatings | 30 | 2070 |
| Mt. Simon sandstone | | |
| Sandstone, yellow to pink, medium- to very coarse-grained, containing some pebbles | 185 | 2255 |
| Same, and shale, red | 5 | 2260 |
| Conglomerate, pink | 5 | 2265 |
| Sandstone, pink, fine- to coarse-grained; some shale, red | 30 | 2295 |
| Sandstone, red, pink, and brown, medium- to coarse-grained | 150 | 2445 |
| Conglomerate, pink | 5 | 2450 |
| Sandstone, pink, medium- to very coarse-grained, containing some pebbles | 24 | 2474 |
| Sandstone, pink, red, and buff, coarse-grained | 96 | 2570 |
| Sandstone, purple, fine- to coarse-grained, and some shale, sandy, red | 55 | 2625 |
| Sandstone, purple, very coarse-grained, grading down to conglomerate | 75 | 2700 |
| Sandstone, pink, purple, yellow, medium- to coarse-grained; and an occasional bed of shale, sandy, red | 65 | 2765 |
| Conglomerate, purple and yellow | 5 | 2770 |
| Sandstone, purple, pink, and yellow, coarse-grained | 20 | 2790 |
| Same, grading down to conglomerate | 25 | 2815 |
| Shale, sandy, purple | 5 | 2820 |
| Conglomerate, purple | 10 | 2830 |
| Shale, sandy, grayish-brown, and sandstone, purple, coarse-grained | 10 | 2840 |
| Sandstone, purple, yellow, and pink, fine- to coarse-grained | 190 | 3030 |
| No record | 5 | 3035 |
| Sandstone, as above, but silty | 15 | 3050 |
| Sandstone, red and pink, medium- to coarse-grained | 160 | 3210 |
| Sandstone, red and white, fine- to medium-grained | 20 | 3230 |
| Sandstone, silty, red, coarse-grained | 5 | 3235 |
| Sandstone, pink, red, and white, fine- to very coarse-grained | 85 | 3320 |
| Sandstone, red, pink, and yellow, medium- to coarse-grained, containing scattered fragments of feldspar and granite | 260 | 3580 |
| Arkose, pink, buff, and brown, fine- to coarse-grained | 90 | 3670 |
| Arkose, brown, fine-grained; shale, red and green | 25 | 3695 |
| Arkose, red to brown, fine- to coarse-grained, biotite flakes in lower half | 65 | 3760 |
| Pre-Cambrian systems | | |
| Granite, red | 12 | 3772 |

*Well No. 11.—Mendota City, SW. ¼ SW. ¼ NE. ¼ sec. 33, T. 36 N., R. 1 E. (Mendota Twp.), LaSalle County, Mendota quadrangle*[a].

Elevation 760 feet

| | | |
|---|---|---|
| Pleistocene system (details omitted) | 160 | 160 |
| Ordovician system | | |
| Mohawkian series | | |
| Galena-Platteville formations | | |
| "Limestone" | 200 | 360 |
| Chazyan series | | |
| "St. Peter sandstone" | 175 | 535 |
| Prairie du Chien series | | |
| Oneota formation | | |
| "Limestone" | 117 | 652 |
| Cambrian system | | |
| Jordan formation | | |
| "Sandstone" | 60 | 712 |
| Trempealeau formation | | |
| "Limestone" | 88 | 800 |
| "Shale, white" | 50 | 850 |
| "Limestone" | 16 | 866 |
| Franconia formation | | |
| "Sandstone" | 9 | 875 |
| "Limestone" | 7 | 882 |
| "Sandstone" | 2 | 884 |
| "Limestone" | 16 | 900 |
| "Calciferous sandstone" | 90 | 990 |
| Dresbach group | | |
| Galesville-Eau Claire-Mt. Simon formations | | |
| "Potsdam Group" | 1142 | 2132 |

[a]Driller's log, no samples on file.

*Well No. 14.—C. W. Varner & Johnson Bros.—Illinois School for Boys, SW. ¼ SE. ¼ SW. ¼ sec. 8, T. 35 N., R. 5 E. (Mission Twp.), LaSalle County, Plano quadrangle.*

Elevation 600 feet

| | Thickness Ft. | Depth Ft. |
|---|---|---|
| Ordovician system | | |
| Prairie du Chien series | | |
| Shakopee formation | | |
| Dolomite, partly sandy, yellow to light gray, and chert, oolitic, white | 33 | 33 |
| New Richmond sandstone | | |
| Sandstone, white, very fine- to coarse-grained | 57 | 90 |
| Oneota formation | | |
| Dolomite, white, and sandstone, very dolomitic, white | 15 | 105 |
| Sandstone, dolomitic, white, fine- to coarse-grained | 10 | 115 |
| Dolomite, light gray to white, finely crystalline | 10 | 125 |
| Dolomite, white, finely to medium crystalline, slightly glauconitic | 20 | 145 |
| Dolomite, cherty, white to light gray, finely crystalline | 80 | 225 |
| Dolomite, white to light gray, glauconitic | 10 | 235 |
| Cambrian system | | |
| St. Croixan series | | |
| Jordan formation | | |
| Dolomite, sandy, light gray to white | 15 | 250 |
| Dolomite, cherty, white to light brown, slightly glauconitic | 10 | 260 |
| Dolomite, sandy, white, glauconitic | 5 | 265 |
| Shale, grayish-green; dolomite, sandy, pink | 5 | 370 |
| Dolomite, cherty, white | 10 | 380 |
| Same, and sandstone, white, gray, and brown, fine- to medium-grained | 7.5 | 387.5 |
| Dolomite, sandy, white, light gray, and pink, glauconitic | 72.5 | 460 |
| Same, containing quartz geodes | 15 | 475 |
| Dolomite, sandy, cherty, light brownish-gray, and some shale, sandy, light green | 20 | 495 |
| Dolomite, light gray, glauconitic | 10 | 505 |
| Dolomite, sandy, light brownish-gray, containing quartz geodes | 5 | 510 |
| Dolomite, light gray, glau conitic | 45 | 555 |
| Dolomite, sandy, light gray to white | 5 | 560 |
| Dolomite, light gray, glauconitic | 30 | 590 |
| Franconia formation | | |
| Dolomite, very sandy, light gray, glauconitic | 10 | 600 |
| Sandstone, very dolomitic, greenish-gray, glauconitic, fine-grained, and a little dolomite as above | 105 | 705 |
| Sandstone, dolomitic, gray, fine- to coarse-grained, glauconitic, and dolomite, sandy, light gray, glauconitic | 25 | 730 |
| Dolomite, very sandy, pink, glauconitic | 5 | 735 |
| Dresbach group | | |
| Galesville sandstone | | |
| Dolomite, very sandy, pink; some sandstone, white, fine- to coarse-grained | 20 | 755 |
| Sandstone, white, fine- to coarse-grained; streaks of dolomite, sandy, light gray to pink | 105 | 860 |
| Sandstone, white, fine- to medium-grained | 60 | 920 |
| Eau Claire formation | | |
| Sandstone, light gray, very fine- to fine-grained; dolomite, silty, dark gray | 15 | 935 |
| Siltstone, light gray, glauconitic | 20 | 955 |
| Same, and dolomite, sandy, white to tan | 30 | 985 |

*Well No. 15.—R. N. Peddicord—R. N. Peddicord, SW. ¼ SE. ¼ NE. ¼ sec. 32, T. 34 N., R. 1 E. (Rutland Twp.), LaSalle County, Marseilles quadrangle*[a].

Elevation 720 feet

| | Thickness Ft. | Depth Ft. |
|---|---|---|
| Pleistocene system (details omitted) | 269 | 269 |
| Pennsylvanian system (details omitted) | 65 | 334 |
| Ordovician system | | |
| Mohawkian series | | |
| Platteville formation | | |
| "Limestone" | 25 | 359 |
| Chazyan series | | |
| "St. Peter sandstone" | 195 | 554 |
| Prairie du Chien series | | |
| Shakopee formation | | |
| "Calciferous sandrock" | 50 | 604 |
| New Richmond formation | | |
| "Sandstone" | 45 | 649 |
| Oneota formation | | |
| "Limestone" | 265 | 914 |
| Cambrian system | | |
| St. Croixan series | | |
| Jordan formation | | |
| "Calciferous sandstone" | 25 | 939 |
| Trempealeau-Franconia formations | | |
| "Limerock" | 72 | 1011 |
| "Hard sand" | 15 | 1026 |
| "Limestone" | 95 | 1121 |
| "Shale, blue" | 73 | 1194 |
| "Limestone" | 34 | 1228 |
| "Shale" | 3 | 1231 |
| "Limestone" | 20 | 1251 |
| Franconia-Galesville formations | | |
| "Sandstone" | 15 | 1266 |

[a]Driller's log, no samples on file.

| | Thickness Ft. | Depth Ft. |
|---|---|---|
| "Sandstone, white" | 265 | 1531 |
| Eau Claire formation | | |
| "Limestone" | 152 | 1683 |
| "Shale, blue" | 50 | 1733 |
| "Shale, red" | 5 | 1738 |
| "Shale, blue" | 60 | 1798 |
| "Slate" | 112 | 1910 |
| "Shale" | 9 | 1919 |
| "Limestone" | 20 | 1939 |
| Mt. Simon formation | | |
| "Sandstone" | 214 | 2153 |
| "Limestone" | 5 | 2158 |
| "Sandstone" | 125 | 2283 |

*Well No. 17.—Milaeger Smith—Morris City No. 4, NE. ¼ NW. ¼ NE. ¼ sec. 9, T. 33 N., R. 7 E. (Morris Twp.), Grundy County, Morris quadrangle.*

Elevation 510 feet

| | Thickness Ft. | Depth Ft. |
|---|---|---|
| Pleistocene system (details omitted) | 50 | 50 |
| Pennsylvanian system (details omitted) | 85 | 135 |
| Ordovician system | | |
| Mohawkian series | | |
| Galena-Platteville formation | | |
| Limestone, dolomitic, cherty, buff, and dolomite, brown and gray | 65 | 200 |
| Dolomite, light brown, very finely crystalline | 20 | 220 |
| Limestone, buff to light gray, lithographic | 55 | 275 |
| Dolomite, light gray to light brown, very finely crystalline | 40 | 315 |
| Glenwood formation | | |
| Dolomite, sandy, buff and light brown, grading to sandstone | 10 | 325 |
| Chazyan series | | |
| St. Peter sandstone | | |
| Sandstone, white, fine- to medium-grained | 578 | 903 |
| Prairie du Chien series | | |
| Oneota formation | | |
| Chert, dolomitic, white to pink | 12 | 915 |
| Cambrian system | | |
| St. Croixan series | | |
| Jordan formation | | |
| Sandstone, light gray, fine- to coarse-grained | 18 | 933 |
| Dolomite, sandy, cherty, white to pink, and a little shale, green | 37 | 970 |
| Trempealeau formation | | |
| Dolomite, slightly sandy, white to light brown | 55 | 1025 |
| Dolomite, sandy, white and purple, glauconitic | 10 | 1035 |
| Dolomite, gray, glauconitic | 30 | 1065 |
| Dolomite, light gray to light brown | 40 | 1105 |
| Dolomite, light buff to pink, glauconitic | 15 | 1120 |
| Franconia formation | | |
| Dolomite, sandy, light gray, glauconitic | 80 | 1200 |
| Dolomite, very sandy, buff, glauconitic | 15 | 1215 |
| Dolomite, sandy, light buff, glauconitic | 30 | 1245 |
| Sandstone, dolomitic, light gray, fine- to coarse-grained, glauconitic, and streaks of sandy dolomite | 20 | 1265 |
| Dresbach group | | |
| Galesville formation | | |
| Sandstone, light gray, fine- to coarse-grained, and streaks of dolomite, sandy, light brown | 190 | 1455 |
| Eau Claire formation | | |
| Shale, greenish-gray | 46 | 1501 |

*Well No. 18.—Grundy County Poor Farm, SE. ¼ SE. ¼ SW. ¼ sec. 33, T. 33 N., R. 7 E. (Wauponsee Twp.), Grundy County, Morris quadrangle.*

Elevation 570 feet

| | Thickness Ft. | Depth Ft. |
|---|---|---|
| Pleistocene system (details omitted) | 50 | 50 |
| Pennsylvanian system (details omitted) | 199 | 249 |
| Ordovician system | | |
| Mohawkian series | | |
| Galena formation | | |
| Limestone, dolomitic, light brown, fine- to coarse-grained | 66 | 315 |
| Decorah formation | | |
| Limestone, dolomitic, cherty, brown and gray, partly oolitic, and shale, calcareous, brown | 10 | 325 |
| Limestone, light brown, fine- to medium-grained | 15 | 340 |
| Limestone, dolomitic, light brown, fine-grained; shale, calcareous, gray | 20 | 360 |
| Platteville formation | | |
| Limestone, dolomitic, cherty, brown and buff, very fine-grained | 30 | 390 |
| Limestone, dolomitic, cherty, silty, brown; dolomite, brown | 8 | 398 |
| Limestone, gray and buff, lithographic | 27 | 425 |
| Limestone, dolomitic, mottled buff, brown, and gray, and occasional streaks of shale, calcareous, brown | 35 | 460 |
| Limestone, dolomitic, partly cherty, gray and brown; dolomite, brown, finely crystalline | 30 | 490 |
| Limestone, dolomitic, light brown, lithographic to very fine-grained; dolomite, brown, finely crystalline | 20 | 510 |
| Glenwood formation | | |
| Dolomite, drab; shale, sandy, brown; sandstone, dolomitic, fine- and coarse-grained | 5 | 515 |
| Sandstone, light buff, fine- to coarse-grained | 35 | 550 |

| | Thickness Ft. | Depth Ft. |
|---|---|---|
| Dolomite, silty, light brown; shale, dolomitic, silty, green and gray | 25 | 575 |
| Chazyan series | | |
| St. Peter sandstone | | |
| Sandstone, light buff, fine-grained | 40 | 615 |
| Sandstone, light buff, fine- to coarse-grained | 105 | 720 |
| Prairie du Chien series | | |
| Shakopee formation | | |
| Shale, silty, green; dolomite, sandy, buff | 10 | 730 |

*Well No. 19.—Milaeger Well Drilling Company—E. I. Dupont de Nemours No. 3, SW. ¼ SW. ¼ NE. ¼ sec. 29, T. 33 N., R. 6 E., (Norman Twp.), Grundy County, Marseilles quadrangle.*

Elevation 606 feet

| | Thickness Ft. | Depth Ft. |
|---|---|---|
| Pleistocene system (details omitted) | 136 | 136 |
| Pennsylvanian system (details omitted) | 129 | 265 |
| Ordovician system | | |
| Mohawkian series | | |
| Platteville formation | | |
| Limestone, light brown to gray, fine-grained; dolomite, brown | 35 | 300 |
| Dolomite, cherty, brownish-gray, very finely crystalline | 30 | 330 |
| Same, and limestone, dolomitic, light gray | 20 | 350 |
| Chazyan series | | |
| St. Peter sandstone | | |
| Sandstone, white, fine-grained | 40 | 390 |
| Sandstone, white, fine- to medium-grained | 45 | 435 |
| Sandstone, white, fine- to coarse-grained | 50 | 485 |
| Sandstone, white, fine-grained | 55 | 540 |
| Sandstone, white, fine- to medium-grained | 35 | 575 |
| Sandstone, white, fine-grained; shale, gray | 15 | 590 |
| Prairie du Chien series | | |
| Shakopee formation | | |
| Limestone; chert, white, oolitic; shale, sandy, green | 5 | 595 |
| Dolomite, cherty, light gray, and red; shale, green | 15 | 610 |
| Dolomite, brown, finely crystalline | 15 | 625 |
| Dolomite, argillaceous, red | 7 | 632 |
| Dolomite, cherty, sandy, gray | 18 | 650 |
| New Richmond formation | | |
| Dolomite, sandy, partly cherty, gray to brown; sandstone, white, fine-grained | 48 | 698 |
| Sandstone, white, fine- to coarse-grained | 37 | 735 |
| Oneota formation | | |
| Dolomite, light gray, finely, crystalline | 25 | 760 |
| Dolomite, cherty, light gray | 35 | 795 |
| Dolomite, white, medium crystalline | 40 | 835 |
| Dolomite, cherty, white to gray | 103 | 938 |
| Cambrian system | | |
| St. Croixan series | | |
| Jordan formation | | |
| Sandstone, dolomitic, white, fine- to coarse-grained; dolomite, sandy, white | 52 | 990 |
| Trempealeau formation | | |
| Dolomite, white, finely crystalline | 20 | 1010 |
| Dolomite, sandy, white, gray, pink, very finely crystalline | 65 | 1075 |
| Dolomite, glauconitic, light gray, very finely crystalline | 15 | 1090 |
| Dolomite, sandy, light gray, very finely crystalline | 20 | 1110 |
| Dolomite, brown, very finely crystalline; geodic quartz | 20 | 1130 |
| Dolomite, sandy, glauconitic, gray, very finely crystalline | 90 | 1220 |
| Franconia formation | | |
| Sandstone, dolomitic, glauconitic, gray, very fine-grained | 90 | 1310 |
| Same; and dolomite, sandy, glauconitic, gray, very finely crystalline | 65 | 1375 |
| Dresbach group | | |
| Galesville formation | | |
| Dolomite, sandy, gray | 15 | 1390 |
| Sandstone, white, fine- to coarse-grained; little dolomite as above | 85 | 1475 |
| Sandstone, white, fine- to coarse-grained | 45 | 1520 |
| Eau Claire formation | | |
| Sandstone, dolomitic, buff, very fine-grained | 5 | 1525 |
| Dolomite, sandy, brown; shale, gray | 20 | 1545 |

*Well No. 21.—J. O. Heflin—I. and M. Ship Canal State Park, Marseilles, NE. ¼ SE. ¼ NE. ¼ sec. 24, T. 33 N., R. 4 E. (Fall River Twp.), LaSalle County, Marseilles quadrangle.*

Elevation 490 feet

| | Thickness Ft. | Depth Ft. |
|---|---|---|
| Pennsylvanian system (details omitted) | 100 | 100 |
| Ordovician system | | |
| Mohawkian series | | |
| Platteville formation | | |
| Limestone, cherty, silty, light gray, lithographic | 5 | 105 |
| Chazyan series | | |
| St. Peter formation | | |
| Sandstone, white, fine- to coarse-grained | 70 | 175 |
| Sandstone, buff to light brown, fine- to medium-grained | 45 | 220 |
| Sandstone, light brown, fine- to coarse-grained | 20 | 240 |

| | Thickness Ft. | Depth Ft. |
|---|---|---|
| Sandstone (no sample) | 10 | 250 |
| Sandstone, brownish-gray, fine- to medium-grained, slightly argillaceous in lower part | 70 | 320 |
| Sandstone, light brown, fine-grained | 10 | 330 |
| Sandstone, buff, medium-grained; shale, sandy, brown | 10 | 340 |
| Same, but containing quartz pebbles and oolitic chert fragments | 10 | 350 |
| Prairie du Chien series | | |
| Shakopee formation | | |
| Dolomite, sandy, white, and shale, dolomitic, sandy, green | 5 | 355 |
| Shale, as above; dolomite, cherty, sandy, red, pink, and brown | 10 | 365 |
| Dolomite, cherty, light pinkish-buff | 15 | 380 |
| Dolomite, sandy, white; sandstone, dolomitic, buff | 5 | 385 |
| Dolomite, sandy, reddish-gray; shale, dolomitic, gray | 5 | 390 |
| Dolomite, sandy, buff and gray, some pink spots | 20 | 410 |
| New Richmond formation | | |
| Sandstone, dolomitic, argillaceous, buff, fine- to medium-grained | 10 | 420 |
| Sandstone, white, fine- to coarse-grained | 25 | 445 |
| Same, and dolomite, sandy, buff | 10 | 455 |
| Sandstone, white and buff, fine- to medium-grained | 35 | 490 |
| Sandstone, dolomitic, buff, fine- to coarse-grained | 10 | 500 |

*Well No. 24.—Layne North Central—Ottawa City No. 8B, NE. ¼ SW. ¼ SW. ¼ sec. 1, T. 33 N., R. 3 E. (Ottawa Twp.), LaSalle County, Ottawa quadrangle.*

Elevation 488.6 feet

| | Thickness Ft. | Depth Ft. |
|---|---|---|
| Pleistocene system (no record) | 10 | 10 |
| Ordovician system | | |
| Chazyan series | | |
| St. Peter sandstone | | |
| Sandstone, white, fine- to coarse-grained | 155 | 165 |
| Prairie du Chien series | | |
| Shakopee formation | | |
| Dolomite, cherty, light gray | 10 | 175 |
| Dolomite, light gray | 15 | 190 |
| Dolomite, sandy, cherty, light gray | 95 | 285 |
| Dolomite, partly sandy, light gray | 10 | 295 |
| New Richmond sandstone | | |
| Sandstone, white, very fine- to coarse-grained; streaks of dolomite, sandy, light gray | 75 | 370 |
| Sandstone, dolomitic, light gray, fine-grained | 20 | 390 |
| Dolomite, sandy, light gray | 5 | 395 |
| Sandstone, dolomitic, light gray, fine- to very coarse-grained | 10 | 405 |
| Oneota formation | | |
| Dolomite, partly sandy, cherty, light gray, finely to medium crystalline | 20 | 425 |
| Dolomite, slightly sandy, white | 15 | 440 |
| Same, and sandstone, dolomitic, light gray, fine- to coarse-grained | 10 | 450 |
| Dolomite, white, finely to medium crystalline | 10 | 460 |
| Dolomite, sandy, white; sandstone, dolomitic, light gray, coarse-grained | 10 | 470 |
| Dolomite, white, finely to medium crystalline | 25 | 495 |
| Dolomite, cherty, white to light gray, finely to medium crystalline | 40 | 535 |
| Dolomite, light gray to buff, slightly glauconitic | 5 | 540 |
| Dolomite, cherty, light gray, slightly sandy in lower part | 25 | 565 |
| Cambrian system | | |
| St. Croixan series | | |
| Jordan formation | | |
| Sandstone, white, fine- to coarse-grained, and streaks of dolomite, sandy, white to pink | 45 | 610 |
| Trempealeau formation | | |
| Dolomite, slightly sandy, white to light gray, some pink and green spots | 50 | 660 |
| Dolomite, light gray, slightly glauconitic, sandy in middle part | 45 | 705 |
| Dolomite, light gray to light brownish-gray | 50 | 755 |
| Same, slightly glauconitic, and containing pink spots in lower half | 75 | 830 |
| Dolomite, sandy, white, light gray, and buff, slightly glauconitic | 25 | 855 |
| Franconia formation | | |
| Sandstone, dolomitic, gray, fine- to coarse-grained, glauconitic, and streaks of dolomite, sandy, gray, glauconitic | 55 | 910 |
| Dolomite, sandy, gray to brownish-gray, glauconitic | 90 | 1000 |
| Sandstone, dolomitic, light gray, coarse-grained; streaks of dolomite, sandy, pink to light gray, glauconitic | 45 | 1045 |
| Dresbach group | | |
| Galesville sandstone | | |
| Sandstone, dolomitic, light gray, coarse-grained; dolomite, sandy, light gray | 25 | 1070 |

| | Thickness Ft. | Depth Ft. |
|---|---|---|
| Sandstone, white, fine- to coarse-grained | 105 | 1175 |

*Well No. 25.—Layne North Central Co.—Ottawa City No. 8A, NE. ¼ NE. ¼ SE. ¼ sec. 14, T. 33 N., R. 3 E. (South Ottawa Twp.), LaSalle County, Ottawa quadrangle.*

Elevation 582 feet

| | Thickness Ft. | Depth Ft. |
|---|---|---|
| Pleistocene system (details omitted) | 29 | 29 |
| Pennsylvanian system (details omitted) | 86 | 115 |
| Ordovician system | | |
| Chazyan series | | |
| St. Peter sandstone | | |
| Sandstone, light gray, medium- to coarse-grained | 45 | 160 |
| Same; shale, sandy, green and gray | 20 | 180 |
| Sandstone, white, fine- to medium-grained | 92 | 272 |
| Chert, bluish; shale, green | 8 | 280 |
| Prairie du Chien series | | |
| Shakopee formation | | |
| Dolomite, sandy, gray to brown | 20 | 300 |
| Same, but cherty | 40 | 340 |
| Dolomite, light gray | 10 | 350 |
| Dolomite, cherty, light gray, sandy in upper part | 30 | 380 |
| New Richmond formation | | |
| Sandstone, cherty, dolomitic, gray, fine- to medium-grained; streaks of dolomite, sandy, cherty, gray | 20 | 400 |
| Sandstone, white to pinkish, fine- to coarse-grained | 90 | 490 |
| Dolomite, sandy, gray; shale, green | 10 | 500 |
| Sandstone, partly cherty, partly dolomitic, white, fine- to medium-grained | 15 | 515 |
| Oneota formation | | |
| Dolomite, cherty, light gray | 30 | 545 |
| Dolomite, sandy, cherty, light gray | 70 | 615 |
| Dolomite, cherty, light gray, partly glauconitic | 30 | 645 |
| Dolomite, sandy, cherty, light brown | 28 | 673 |
| Cambrian system | | |
| St. Croixan series | | |
| Jordan formation | | |
| Sandstone, dolomitic, white, fine- to coarse-grained | 32 | 705 |
| Trempealeau formation | | |
| Dolomite, sandy, gray, pink spots, partly glauconitic | 60 | 765 |
| Dolomite, sandy, partly cherty, brownish-gray, glauconitic | 70 | 835 |
| Dolomite, partly cherty, light brown, partly glauconitic | 90 | 925 |
| Franconia formation | | |
| Sandstone, dolomitic, greenish-gray, fine-grained, glauconitic, and dolomite, sandy, brownish- to greenish-gray, glauconitic | 120 | 1045 |
| Dolomite, gray, glauconitic | 30 | 1075 |
| Sandstone, dolomitic, gray, fine- to medium-grained, glauconitic | 30 | 1105 |
| Dresbach group | | |
| Galesville formation | | |
| Dolomite, sandy, pinkish- to brownish-gray | 40 | 1145 |
| Sandstone, partly dolomitic, white to buff, fine- to coarse-grained | 120 | 1265 |
| Eau Claire formation | | |
| Dolomite, sandy, brown; shale, dolomitic, gray | 25 | 1290 |

*Well No. 26.—John Schomas—Ottawa Silica Co., NW. ¼ SW. ¼ NW. ¼ sec. 10, T. 33 N., R. 3 E. (Ottawa Twp.), LaSalle County, Ottawa quadrangle.*

Elevation 490 feet

| | Thickness Ft. | Depth Ft. |
|---|---|---|
| Ordovician system | | |
| Chazyan series | | |
| St. Peter sandstone | | |
| "Sandstone" (no samples) | 67 | 67 |
| Sandstone, white, fine- to coarse-grained | 73 | 140 |
| Shale, silty, sandy, gray, containing chert pebbles | 5 | 145 |
| Prairie du Chien series | | |
| Shakopee formation | | |
| Dolomite, sandy, gray to buff, and an occasional bed of sandstone, dolomitic | 52 | 197 |
| Dolomite, gray, finely crystalline | 25 | 222 |
| Dolomite, sandy, gray | 25 | 247 |
| Dolomite, sandy, cherty, gray to buff | 53 | 300 |
| New Richmond formation | | |
| Dolomite, sandy, cherty, gray; sandstone, white, fine- to coarse-grained | 25 | 325 |
| Sandstone, dolomitic, white, fine- to coarse-grained | 85 | 410 |
| Oneota formation | | |
| Dolomite, sandy, partly cherty, gray, finely crystalline | 24 | 434 |
| Dolomite, very cherty, gray | 6 | 440 |
| Dolomite, white, finely to medium crystalline | 50 | 490 |
| Same, but cherty, and glauconitic in lower part | 50 | 540 |
| Cambrian system | | |
| St. Croixan series | | |
| Jordan formation | | |
| Dolomite, sandy, cherty, buff to pink, finely crystalline | 20 | 560 |
| Dolomite, sandy, very cherty, and sandstone, dolomitic, white, fine- to coarse-grained | 33 | 593 |
| Trempealeau formation | | |
| Dolomite, cherty, sandy, gray, pink, and buff, finely crystalline | 102 | 695 |
| Same, but glauconitic | 35 | 730 |

| | Thickness Ft. | Depth Ft. |
|---|---|---|
| Dolomite, slightly sandy, gray, very finely crystalline | 48 | 778 |
| Dolomite, sandy, buff, gray, and pink, glauconitic | 32 | 810 |
| Franconia formation | | |
| Sandstone, very dolomitic, gray, glauconitic, grading to dolomite | 105 | 915 |
| Dolomite, sandy, gray, glauconitic | 35 | 950 |
| Dolomite, sandy, buff and pink; sandstone, dolomitic, glauconitic | 40 | 990 |
| Dresbach group | | |
| Galesville formation | | |
| Sandstone, dolomitic, buff and pink, containing some streaks of sandy dolomite | 62 | 1052 |
| "Sandstone" (no samples) | 8 | 1060 |

*Well No. 30.—J. C. Schomas—Starved Rock State Park NW. ¼ NW. ¼ NW. ¼ sec. 22, T. 33 N., R. 2 E. (Deer Park Twp.), LaSalle County, Ottawa quadrangle.*[a]

Elevation 460 feet

| | Thickness Ft. | Depth Ft. |
|---|---|---|
| Ordovician system | | |
| Chazyan series | | |
| "St. Peter sandstone" | 28 | 28 |
| Prairie du Chien series | | |
| "Shakopee dolomite" | 180 | 208 |
| "New Richmond sandstone" | 190 | 398 |
| Oneota formation | | |
| "Limestone, blue" | 200 | 598 |
| Cambrian system | | |
| St. Croixan series | | |
| Jordan formation | | |
| "Sandstone, white" | 39 | 637 |

[a]Driller's log, no samples on file.

*Well No. 37.—Sewell Well Company—Peru City No. 5, NE. ¼ NE. ¼ NE. ¼ sec. 20, T. 33 N., R. 1 E. (Peru Twp.), LaSalle County, LaSalle quadrangle.*

Elevation 493 feet

| | Thickness Ft. | Depth Ft. |
|---|---|---|
| Pennsylvanian system (details omitted) | 390 | 390 |
| Silurian system | | |
| Niagaran series | | |
| Dolomite, silty, gray, finely crystalline, and occasional streaks of shale, dolomitic gray | 115 | 505 |
| Limestone, argillaceous, pink and buff, slightly glauconitic | 15 | 520 |
| Same, and dolomite, greenish-gray, finely crystalline | 15 | 535 |
| Limestone, argillaceous, dolomitic, gray, and occasional streaks of shale | 60 | 595 |
| Dolomite, cherty, gray, finely to coarsely crystalline | 25 | 620 |
| Dolomite, white, buff, and pink, finely crystalline; occasional streaks of shale, gray and green | 70 | 690 |
| Dolomite, as above; dolomite, very sandy, gray, finely crystalline | 10 | 700 |
| Dolomite, white and yellow, finely crystalline | 40 | 740 |
| Dolomite, red, pink, gray, finely crystalline, sandy in part | 25 | 765 |
| Alexandrian series | | |
| Dolomite, light gray, finely crystalline | 40 | 805 |
| Same, and shale, green, and sandstone, dolomitic, greenish-gray | 15 | 820 |
| Ordovician system | | |
| Cincinnatian series | | |
| Maquoketa formation | | |
| Shale, dolomitic, greenish-gray | 50 | 870 |
| Same; dolomite, gray and brownish-gray | 30 | 900 |
| Shale, dolomitic, greenish-gray | 25 | 925 |
| Dolomite, argillaceous, greenish- to brownish-gray; occasional beds of shale, dolomitic, brownish-gray | 30 | 955 |
| Shale, dolomitic, brownish-gray | 25 | 980 |
| Mohawkian series | | |
| Galena formation | | |
| Dolomite, pinkish-brown to buff, medium crystalline | 210 | 1190 |
| Decorah formation | | |
| Dolomite, buff to brown, finely to medium crystalline, and a little shale, brown | 35 | 1225 |
| Dolomite, light brown and gray | 10 | 1235 |
| Platteville formation | | |
| Dolomite, light brown, finely crystalline | 30 | 1265 |
| Limestone, dolomitic, buff and light brown, sublithographic | 65 | 1330 |
| Dolomite, buff and light brown, with gray spots, very finely crystalline | 25 | 1355 |
| Dolomite, slightly cherty, brown, very finely crystalline | 10 | 1365 |
| Glenwood formation | | |
| Sandstone, dolomitic, buff, fine- to coarse-grained | 15 | 1380 |
| Chazyan series | | |
| St. Peter sandstone | | |
| Sandstone, white, fine- to coarse-grained | 25 | 1405 |
| Sandstone, buff, fine- to medium-grained | 95 | 1500 |
| Shale, green; chert, oolitic; dolomite, sandy, gray; sandstone, dolomitic | 15 | 1515 |

| | Thickness Ft. | Depth Ft. |
|---|---|---|
| Prairie du Chien series | | |
| Shakopee formation | | |
| Dolomite, sandy, cherty, buff, brown, and gray, and little sandstone, white, fine- to coarse-grained | 85 | 1600 |
| Dolomite, slightly sandy, light brown, and a little sandstone, dolomitic, white, fine- to coarse-grained | 30 | 1630 |
| Dolomite as above, but cherty with oolitic chert | 50 | 1685 |
| New Richmond formation | | |
| Dolomite, very sandy, grading to sandstone, very dolomitic, fine- to coarse-grained | 10 | 1695 |
| Sandstone, gray, medium- to coarse-grained, with occasional beds of very sandy dolomite | 75 | 1770 |
| Same, but sandstone is fine- to very coarse-grained | 45 | 1815 |
| Oneota formation | | |
| Dolomite, white to light gray, finely to medium crystalline | 15 | 1830 |
| Dolomite, very cherty, sandy, gray to buff | 17 | 1847 |
| Dolomite, cherty, light gray to buff | 93 | 1940 |
| Same, but slightly glauconitic | 15 | 1955 |
| Dolomite, cherty, slightly sandy, buff | 15 | 1970 |
| Cambrian system | | |
| St. Croixan series | | |
| Jordan formation | | |
| Dolomite, cherty, gray, buff, pink | 5 | 1975 |
| Shale, dolomitic, finely sandy, bluish-green | 2 | 1977 |
| No record | 18 | 1995 |
| Sandstone, light gray, fine- to coarse-grained; dolomite, sandy, white to pinkish | 40 | 2035 |
| Trempealeau formation | | |
| No record | 15 | 2050 |
| Dolomite, sandy, pink and buff, finely crystalline | 25 | 2075 |
| Same, but slightly glauconitic | 45 | 2120 |
| No record | 30 | 2150 |
| Dolomite, cherty, buff and gray, very finely crystalline | 40 | 2190 |
| No record | 15 | 2205 |
| Dolomite, buff and pink, slightly glauconitic, geodic quartz | 40 | 2245 |
| Franconia formation | | |
| Dolomite, sandy, argillaceous, greenish-gray, glauconitic, grading to sandstone, very dolomitic, glauconitic | 85 | 2330 |
| Dolomite, gray, buff, and pink, and dolomite, argillaceous brown | 10 | 2340 |
| Dolomite, buff to gray, glauconitic | 15 | 2355 |
| Same, but finely sandy; sandstone, dolomitic, gray, glauconitic | 20 | 2375 |
| Sandstone, buff, medium- to coarse-grained; dolomite, sandy, white, glauconitic | 15 | 2390 |
| Dresbach group | | |
| Galesville formation | | |
| Sandstone, buff, fine- to coarse-grained, and occasional beds of sandy dolomite | 111 | 2501 |
| No record | 74 | 2575 |
| Eau Claire formation | | |
| Dolomite, sandy, argillaceous, brown and gray; sandstone, gray, fine- to medium-grained | 10 | 2585 |
| Shale, silty, dolomitic, greenish-gray | 16 | 2601 |

*Well No. 41.—Sewell Well Company—Depue City No. 4, SE. ¼ SE. ¼ SW. ¼ sec. 35, T. 16 N., R. 10 E. (Selby Twp.), Bureau County, Hennepin quadrangle.*

Elevation 464 feet

| | | |
|---|---|---|
| Pleistocene system (details omitted) | 65 | 65 |
| Pennsylvanian system (details omitted) | 280 | 345 |
| Silurian system | | |
| Niagaran series | | |
| Dolomite, silty, partly cherty, white to light gray, finely crystalline | 205 | 550 |
| Dolomite, silty, light gray, finely crystalline, glauconitic | 20 | 570 |
| Dolomite, silty, cherty, light gray, finely crystalline | 40 | 610 |
| Dolomite, cherty, light buff, finely crystalline | 55 | 665 |
| Dolomite, white to light gray, finely crystalline | 45 | 710 |
| Dolomite, sandy, light gray, finely crystalline | 55 | 765 |
| Dolomite, silty, light gray, finely crystalline | 35 | 800 |
| Alexandrian series | | |
| Dolomite, light buff, finely crystalline, slightly glauconitic | 10 | 810 |
| Dolomite, cherty, light buff to light gray, finely crystalline | 30 | 840 |
| Siltstone, dolomitic, argillaceous, greenish-gray | 10 | 850 |
| Ordovician system | | |
| Cincinnatian series | | |
| Maquoketa formation | | |
| Shale, dolomitic, silty, light greenish-gray, and streaks of dolomite, greenish-gray | 55 | 905 |

| | Thickness Ft. | Depth Ft. |
|---|---|---|
| Dolomite, white to light gray, finely crystalline | 5 | 910 |
| Same, and shale, dolomitic, greenish-gray | 15 | 925 |
| Shale, dolomitic, partly silty, greenish-gray | 80 | 1005 |
| Mohawkian series | | |
| Galena-Platteville formations | | |
| Dolomite, argillaceous, buff to gray, finely crystalline | 10 | 1015 |
| Dolomite, cherty, light buff, finely crystalline | 20 | 1035 |
| Dolomite, light buff, finely crystalline | 130 | 1165 |
| Dolomite, silty, cherty, light buff and brown, finely crystalline | 30 | 1195 |
| Dolomite, cherty, light buff to brown, and gray, finely crystalline | 190 | 1385 |
| Chazyan series | | |
| St. Peter sandstone | | |
| Sandstone, white, medium- to coarse-grained | 30 | 1415 |
| Sandstone, white, very fine- to medium-grained | 72 | 1487 |

*Well No. 42.—Gardner City, center SE. ¼ SE. ¼ sec. 4, T. 31 N., R. 8 E. (Garfield Twp.), Grundy County, Dwight quadrangle.*

Elevation 590 feet

| | Thickness Ft. | Depth Ft. |
|---|---|---|
| Pleistocene system (no record) | 55 | 55 |
| Pennsylvanian system (details omitted) | 135 | 190 |
| Ordovician system | | |
| Cincinnatian series | | |
| Maquoketa formation | | |
| Shale, calcareous, green to gray, and a little limestone, gray in the lower part | 45 | 235 |
| Limestone, dolomitic, argillaceous, gray and some shale, calcareous, gray to brownish-gray | 30 | 265 |
| Shale, calcareous, gray to brownish-gray, and an occasional bed of limestone, gray | 80 | 345 |
| Mohawkian series | | |
| Galena formation | | |
| Limestone, brown, finely to coarsely granular | 210 | 555 |
| Decorah formation | | |
| Limestone, dolomitic, cherty, buff, very finely granular, with shaly surfaces | 30 | 585 |
| Same, and shale, calcareous, dark brownish-gray | 15 | 600 |
| Platteville formation | | |
| Limestone, dolomitic, mottled gray, and brown, sublithographic | 85 | 685 |
| Dolomite, light grayish-brown, very finely crystalline | 40 | 725 |
| Glenwood formation | | |
| Sandstone, white and light buff, fine- to coarse-grained; dolomite, buff, finely crystalline | 75 | 800 |
| Dolomite, cherty, buff, pink, yellow, very finely crystalline | 3 | 803 |
| Sandstone, dolomitic, buff, very fine- to medium-grained; dolomite, buff, finely crystalline | 22 | 825 |
| Chazyan series | | |
| St. Peter sandstone | | |
| Sandstone, white to buff, fine- to coarse-grained | 140 | 965 |
| Shale, dolomitic, partly sandy, green, brown, and gray; dolomite, buff | 10 | 975 |

*Well No. 43.—Layne North Central Co.—Ransom Village, NW. ¼ NW. ¼ SE. ¼ sec. 16, T. 31 N., R. 5 E. (Allen Twp.), LaSalle County.*

Elevation 705 feet

| | Thickness Ft. | Depth Ft. |
|---|---|---|
| Pleistocene system (details omitted) | 150 | 150 |
| Pennsylvanian system (details omitted) | 202 | 352 |
| Ordovician system | | |
| Mohawkian series | | |
| Galena formation | | |
| Limestone, dolomitic, light buff, finely to coarsely granular | 128 | 480 |
| Decorah formation | | |
| Limestone, dolomitic, partly cherty, semi-oolitic, light buff, lithographic to finely granular; some shale, calcareous, brown | 20 | 500 |
| Limestone, partly dolomitic, light gray, lithographic to finely granular, speckled | 20 | 520 |
| Platteville formation | | |
| Limestone, dolomitic, partly cherty, light brown and gray, lithographic to finely granular; some interbedded dolomite in lower part | 50 | 570 |
| Limestone, partly dolomitic, brownish-gray with dark spots, lithographic to finely granular, and some shale, calcareous, brown | 60 | 630 |
| Limestone, cherty, brownish-gray, sublithographic | 10 | 640 |
| Limestone, cherty, brownish-gray, sublithographic; dolomite, light brown, finely crystalline | 30 | 670 |
| Glenwood formation | | |
| Dolomite, sandy, brown, with dark spots | 4 | 674 |
| Sandstone, dolomitic, light gray, fine- to medium-grained | 11 | 685 |

| | Thickness Ft. | Depth Ft. |
|---|---|---|
| Chazyan series | | |
| St. Peter sandstone | | |
| Sandstone, white, fine-grained | 110 | 795 |
| Sandstone, white, fine- to medium-grained | 36 | 831 |

*Well No. 44.—Streator City Well, SW. ¼ NE. ¼ SW. ¼ sec. 25, T. 31 N., R. 3 E. (Bruce Twp.), LaSalle County, Streator quadrangle.*[a]

Elevation 618 feet

| | Thickness Ft. | Depth Ft. |
|---|---|---|
| Pleistocene system (details omitted) | 30 | 30 |
| Pennsylvanian system (details omitted) | 211 | 241 |
| Ordovician system | | |
| Mohawkian series | | |
| Galena-Platteville formations | | |
| "Trenton limestone" | 203 | 444 |
| Chazyan series | | |
| St. Peter sandstone | | |
| "Sandstone" | 225 | 669 |
| Prairie du Chien series | | |
| Shakopee formation | | |
| "Limestone, white" | 90 | 759 |
| New Richmond sandstone | | |
| "Sandrock, white" | 133 | 892 |
| Oneota formation | | |
| "Limestone, white" | 211 | 1103 |
| Cambrian system | | |
| St. Croixan series | | |
| Jordan formation | | |
| "Sandrock, white" | 37 | 1140 |
| Trempealeau formation | | |
| "Limestone, dark gray" | 50 | 1190 |
| "Sandrock, fine, reddish" | 15 | 1205 |
| "Limestone, dark gray" | 13 | 1218 |
| "White and brown sand, mixed" | 1 | 1219 |
| "Limestone, gray" | 18 | 1237 |
| "Sand, white, with some brown" (probably cherty limestone) | 168 | 1405 |
| Franconia formation | | |
| "Shale, blue" | 100 | 1505 |
| "Limestone, dark" | 73 | 1578 |
| "Sandrock, dirty, brown" | 21 | 1599 |
| "Sandrock, limy and shelly" | 2 | 1601 |
| Dresbach group | | |
| Galesville sandstone | | |
| "Sandrock, buff" | 35 | 1636 |
| "Rock" | 102 | 1738 |
| Eau Claire formation | | |
| "Red rock" | 10 | 1748 |
| "Iron, dirty brown" | 17 | 1765 |
| "Lime, soft" | 60 | 1825 |
| "Shale, blue" | 13 | 1838 |
| "Shale, brown, sandy, hard" | 30 | 1868 |
| "Shale, blue, soft" | 20 | 1888 |
| "Shale, pinky" | 95 | 1983 |
| "Sandrock, dark red" | 80 | 2063 |
| "Shale, blue" | 50 | 2113 |
| "Limestone, bluish" | 50 | 2163 |
| "Sandstone, dark drab" | 15 | 2178 |
| "Sandstone, reddish-buff" | 35 | 2213 |
| Mt. Simon formation | | |
| "Sandstone, white" | 283 | 2496 |

[a]Driller's log, no samples on file.

*Well No. 45.—W. H. Gray—Henry City Well, NE. ¼ NE. ¼, sec. 20, T. 13 N., R. 10 E. (Henry Twp.), Marshall County, Lacon quadrangle.*

Elevation 491 feet

| | Thickness Ft. | Depth Ft. |
|---|---|---|
| Pleistocene system (details omitted) | 102 | 102 |
| Pennsylvanian system (details omitted) | 223 | 325 |
| Mississippian system | | |
| Iowa series | | |
| Sweetland Creek shale | | |
| Shale, brownish-gray, containing *Sporangites* | 77 | 402 |
| Devonian system | | |
| Dolomite, sandy, brownish-gray; limestone, gray | 24 | 426 |
| Limestone, partly cherty, buff, lithographic | 59 | 485 |
| Silurian system | | |
| Dolomite, cherty, light buff | 15 | 500 |
| Dolomite, silty, gray | 35 | 535 |
| Dolomite, cherty, buff, finely crystalline | 15 | 550 |
| Dolomite, white to light gray, finely crystalline | 340 | 890 |
| Dolomite, cherty, white to buff | 45 | 935 |
| Dolomite, as above; dolomite, sandy, gray | 30 | 965 |
| Ordovician system | | |
| Cincinnatian series | | |
| Maquoketa formation | | |
| Shale, dolomitic, brownish-gray; streaks of dolomite, argillaceous, gray | 235 | 1200 |
| Mohawkian series | | |
| Galena-Platteville formations | | |
| Limestone, dolomitic, buff, medium to coarsely granular | 145 | 1345 |
| Dolomite, cherty, buff; shale, brown | 10 | 1355 |

*Well No. 46.—Joseph Egerer—Wenona City No. 3, NW. ¼ SE. ¼ NE. ¼ sec. 24, T. 30 N., R. 1 E. (Evans Twp.), Marshall County, Wenona quadrangle.*

Elevation 695 feet

| | Thickness Ft. | Depth Ft. |
|---|---|---|
| Pleistocene and Pennsylvanian systems (no record) | 245 | 245 |
| Pennsylvanian system (details omitted) | 389 | 634 |
| Silurian system | | |
| Niagaran series | | |
| Dolomite, cherty, argillaceous, brown, and shale, dolomitic, green | 16 | 650 |
| Dolomite, cherty, brown, finely crystalline | 35 | 685 |
| Dolomite, cherty, argillaceous, brown to gray, finely crystalline | 145 | 830 |
| Dolomite, brown, finely crystalline | 50 | 880 |
| Dolomite, light gray, finely crystalline, vesicular | 50 | 930 |
| Dolomite, slightly glauconitic, brown, finely crystalline, vesicular | 30 | 960 |

| | Thickness Ft. | Depth Ft. |
|---|---|---|
| Dolomite, cherty, argillaceous, gray, finely crystalline | 10 | 970 |
| Dolomite, light gray, finely crystalline, vesicular | 105 | 1075 |
| Dolomite, light green, white, pink, very finely crystalline | 45 | 1120 |
| Alexandrian series | | |
| Dolomite, slightly cherty, white, finely crystalline, vesicular | 25 | 1145 |
| Siltstone, dolomitic, gray | 10 | 1155 |
| Ordovician system | | |
| Cincinnatian series | | |
| Maquoketa formation | | |
| Shale, dolomitic, gray | 90 | 1245 |
| Same, and dolomite, argillaceous, brown and gray | 10 | 1255 |
| Shale, dolomitic, green, and limestone, dolomitic, light brown, coarsely granular | 5 | 1260 |
| Limestone, dolomitic, brown to light gray, coarsely granular | 15 | 1275 |
| Limestone, dolomitic, argillaceous, grayish-brown, and shale, dolomitic, grayish-brown | 20 | 1295 |
| Shale, dolomitic, grayish-brown | 30 | 1325 |
| Mohawkian series | | |
| Galena formation | | |
| Limestone, dolomitic, light brown to light gray, finely to medium granular | 195 | 1520 |
| Decorah formation | | |
| Limestone, dolomitic, shaly, light to dark brown, finely granular | 10 | 1530 |
| Limestone, dolomitic, cherty, brown and gray, finely granular | 15 | 1545 |
| Same, and shale, calcareous, brown | 10 | 1555 |
| Limestone, dolomitic, gray, sublithographic, and shale, calcareous, gray | 10 | 1565 |
| Platteville formation | | |
| Limestone, dolomitic, cherty, light brown, finely granular | 10 | 1575 |
| Limestone, very dolomitic, finely granular, and dolomite, brown, finely crystalline | 20 | 1595 |
| Limestone, grayish-brown, lithographic to finely granular | 30 | 1625 |
| Same, and shale, calcareous, dark brown | 5 | 1630 |
| Limestone, grayish-brown, lithographic to very finely granular | 35 | 1665 |
| Same, cherty | 10 | 1675 |
| Limestone, dolomitic, brown, finely granular, and dolomite, brown, finely crystalline | 30 | 1705 |
| Glenwood formation | | |
| Dolomite, sandy, brown and gray; shale, silty, dolomitic, gray; sandstone, dolomitic, gray, coarse | 10 | 1715 |
| Chazyan series | | |
| St. Peter sandstone | | |
| Sandstone, buff to white, fine- to coarse-grained | 150 | 1865 |

*Well No. 53.—J. P. Miller Artesian Well Company—Alton Railroad, Dwight, NE. ¼ NW. ¼ SW. ¼ sec. 9, T. 30 N., R. 7 E. (Dwight Twp.), Livingston County, Dwight quadrangle.*

Elevation 641 feet

| | Thickness Ft. | Depth Ft. |
|---|---|---|
| Pleistocene system (no samples; details omitted) | 158 | 158 |
| Pennsylvanian system (no samples; details omitted) (Probably includes some Maquoketa) | 147 | 305 |
| Ordovician system | | |
| Cincinnatian series | | |
| Maquoketa formation | | |
| "Limestone, hard, and streaks of shales" (no samples) | 15 | 320 |
| Shale, calcareous, brownish-gray; limestone, brown and gray | 5 | 325 |
| Limestone, dolomitic, cherty, buff, fine (streaks of shale according to driller) | 75 | 400 |
| Mohawkian series | | |
| Galena-Platteville formations | | |
| Limestone, dolomitic, cherty, buff and gray, fine-grained | 100 | 500 |
| Limestone, very dolomitic, buff, medium-grained | 50 | 550 |
| Limestone, dolomitic, cherty, buff to gray, fine-grained | 75 | 625 |
| Limestone, dolomitic, cherty, buff, sublithographic | 15 | 640 |
| Limestone, dolomitic, buff, gray, sublithographic to fine-grained | 60 | 700 |
| Limestone, dolomitic, cherty, buff to gray, fine-grained | 90 | 790 |
| Chazyan series | | |
| St. Peter sandstone | | |
| Sandstone, buff, fine- to coarse-grained | 310 | 1100 |
| Same; shale, sandy, green | 65 | 1165 |
| Prairie du Chien series | | |
| Oneota formation | | |
| Dolomite, slightly sandy, cherty, white, finely crystalline | 75 | 1240 |
| Dolomite, cherty, white, finely to medium crystalline | 130 | 1370 |
| Dolomite, cherty, oolitic, gray, slightly glauconitic | 10 | 1380 |
| Dolomite, cherty, gray, slightly glauconitic | 15 | 1395 |

| | Thickness Ft. | Depth Ft. |
|---|---|---|
| Same, but non-glauconitic | 25 | 1420 |
| Sandstone, very dolomitic, gray, and dolomite, sandy and cherty | 20 | 1440 |
| Dolomite, sandy, buff | 25 | 1465 |
| Same, but cherty | 65 | 1530 |
| Cambrian system | | |
| St. Croixan series | | |
| Jordan formation | | |
| Dolomite, sandy, cherty, gray and pink | 15 | 1545 |
| Same, and shale, gray | 15 | 1560 |
| Sandstone, dolomitic, white, fine- to coarse-grained | 10 | 1570 |
| Dolomite, very sandy, buff and pink; shale, greenish-gray | 5 | 1575 |
| Trempealeau formation | | |
| Dolomite, sandy, buff | 23 | 1598 |
| Dolomite, sandy, cherty, buff, gray, and pink, glauconitic | 67 | 1665 |
| Dolomite, sandy, brownish-gray and brown | 15 | 1680 |
| Dolomite, cherty, gray, buff and pink | 80 | 1760 |
| Dolomite, slightly sandy, slightly cherty, buff | 75 | 1835 |
| Franconia formation | | |
| Dolomite, slightly sandy, buff, pink, glauconitic | 40 | 1875 |
| Sandstone, very dolomitic, gray, fine-grained, glauconitic | 40 | 1915 |
| Dresbach group | | |
| Galesville formation | | |
| Sandstone, buff, fine- to medium-grained, grading to sandy dolomite | 35 | 1950 |
| Sandstone, buff, fine- to coarse-grained, and streaks of dolomite | 135 | 2085 |
| Eau Claire formation | | |
| Dolomite, argillaceous, sandy, brown; sandstone, dolomitic; shale, brown | 20 | 2105 |

*Well No. 57.—Ira French—Fairbury City No. 3, SW. ¼ NW. ¼ SW. ¼ sec. 3, T. 26 N., R 6. E. (Indian Grove Twp.), Livingston County, Chenoa quadrangle.*

Elevation 690 feet

| | Thickness Ft. | Depth Ft. |
|---|---|---|
| Pleistocene system? | | |
| No record | 36 | 36 |
| Pennsylvanian system (details omitted) | 329 | 365 |
| Silurian system | | |
| Niagaran series | | |
| Dolomite, cherty, silty, gray, finely crystalline | 55 | 420 |
| Dolomite, silty, argillaceous, brownish- to greenish-gray, finely crystalline | 100 | 520 |
| Dolomite, siliceous, buff, coarsely crystalline | 71 | 591 |
| Limestone, dolomitic, silty, gray, finely crystalline; grades to dolomite | 69 | 660 |
| Limestone, dolomitic, white, finely granular | 40 | 700 |
| Alexandrian series | | |
| Dolomite, white, finely crystalline, vesicular | 50 | 750 |
| Sandstone, dolomitic, glauconitic, green, very fine-grained | 20 | 770 |
| Same; limestone, sandy, greenish; siltstone, calcareous, green | 30 | 800 |
| Ordovician system | | |
| Cincinnatian series | | |
| Maquoketa formation | | |
| Shale, dolomitic, green and gray | 40 | 840 |
| Limestone, shaly, gray to brown; shale, calcareous, brownish | 40 | 880 |
| "Limestone" (no samples) | 20 | 900 |
| Shale, calcareous, brownish-gray | 35 | 935 |
| Limestone, silty, brown and gray | 5 | 940 |
| Mohawkian series | | |
| Galena formation | | |
| Limestone, dolomitic, buff, fine-grained | 90 | 1030 |
| Limestone, dolomitic, light brown, coarsely granular | 90 | 1120 |
| Decorah formation | | |
| Limestone, finely sandy, brown; shale, calcareous, gray | 20 | 1140 |
| Limestone, dolomitic, cherty, brown, medium-grained | 10 | 1150 |
| Platteville formation | | |
| Limestone, brown and gray, very fine-grained | 70 | 1220 |
| Limestone, dolomitic, silty, brown and gray, very fine-grained | 40 | 1260 |
| Limestone, cherty, buff and gray; shale, calcareous, brown | 10 | 1270 |
| Limestone, cherty, buff, very fine-grained | 50 | 1320 |
| Limestone, sandy, brown, fine-grained | 10 | 1330 |
| Glenwood formation | | |
| Sandstone, calcareous, brownish, fine- and coarse-grained | 6 | 1336 |
| Sandstone, buff to white, fine- to medium-grained | 54 | 1390 |
| Sandstone, shaly, buff, fine- to medium-grained | 10 | 1400 |
| Chazyan series | | |
| St. Peter sandstone | | |
| Sandstone, light buff to light gray, fine- to coarse-grained | 140 | 1540 |
| "St. Peter, hard" (no samples) | 10 | 1550 |
| Sandstone, white, medium- to coarse-grained | 20 | 1570 |
| Same; chert, white, dense, oolitic; shale, silty, yellow and green | 16 | 1586 |

# APPENDIX D—CLASSIFICATION OF CLASTIC SEDIMENTARY ROCKS AND TEST DATA ON SANDSTONES, SAND, AND GRAVEL

By

H. B. Willman

Table 1.—Classification of Clastic Sedimentary Rocks by Grain Size[a]

| Dimensions | | Descriptive Terms | | |
|---|---|---|---|---|
| Millimeters | Inches (Approx.) | Pieces | Aggregate | Indurated Rock |
| | | Boulder | Boulder gravel | Boulder conglomerate |
| 256 | 10 | | | |
| | | Cobble | Cobble gravel | Cobble conglomerate |
| 64 | 2.5 | | | |
| | | Coarse pebble | Coarse gravel | Coarse conglomerate |
| 40 | 1.5 | | | |
| | | Medium pebble | Medium gravel | Medium conglomerate |
| 20 | 0.75 | | | |
| | | Fine pebble | Fine gravel | Fine conglomerate |
| 4 | 0.158 | | | |
| | | Very coarse sand grain | Very coarse-grained sand | Very coarse-grained sandstone |
| 1 | 0.0394 | | | |
| | | Coarse sand grain | Coarse-grained sand | Coarse-grained sandstone |
| 0.5 | 0.0197 | | | |
| | | Medium sand grain | Medium-grained sand | Medium-grained sandstone |
| 0.25 | 0.0099 | | | |
| | | Fine sand grain | Fine-grained sand | Fine-grained sandstone |
| 0.125 | 0.0049 | | | |
| | | Very fine sand grain | Very fine-grained sand | Very fine-grained sandstone |
| 0.0625 | 0.0024 | | | |
| | | Silt particle | Silt | Siltstone[b] |
| 0.0039 | 0.00015 | | | |
| | | Clay particle | Clay | Claystone[b] |

[a]Modified from classification of C. K. Wentworth in Treatise on Sedimentation, by W. H. Twenhofel and collaborators, Williams & Wilkins Co., Baltimore, Second Edition, p. 202, 1932.

[b]When well-bedded or laminated, siltstones and claystones are also called "shale," the term shale being used especially for rocks which contain large amounts of both silt- and clay-sized grains.

In the above classification the limits applicable to individual pieces or to screened materials do not apply to the naturally occurring aggregates or indurated rocks which contain rock fragments of several size grades. In classifying the natural sands and sandstones it has been convenient to classify them according to the median size, which is the size of openings of a sieve which would split the deposit into 2 equal parts by weight, in other words, the size of the average grain by weight. The size grade in which the median falls determines the classification of the sample. When analyses are made with sieves which have openings equivalent to the limits of the grade sizes, the grade size in which the median falls is obvious from the analysis. In analyses made with other sieves, it may be necessary to plot the analyses in cumulative curves and convert the analyses to the standard grade sizes in order to determine the position of the median.

All gradations from sand to gravel occur and it is logical to consider as sand those materials which contain more than 50 per cent sand grains and as gravel those materials with 50 per cent or more pebbles. However, screen analyses of a large number of deposits which in Illinois are called gravel and are commercially worked as gravel, show that the average gravel deposit contains about 50 per cent sand and that many contain between 50 and 75 per cent sand. The analyses also show that many deposits which have been called gravel in the field descriptions contain more than 50 per cent sand. Therefore, the general terms describing the naturally occurring materials are used as follows:

*Sand.*—Contains 75 to 100 per cent sand grains.

*Pebbly sand.*—A sand containing a conspicuous number of pebbles but less than 25 per cent.

*Sandy gravel.*—Contains 50 to 75 per cent sand grains, and 25 to 50 per cent pebbles.

*Gravel.*—Contains 50 to 100 per cent pebbles.

*Silty or clayey sand and gravel.*—A sand or gravel

TABLE 3.—SIEVE ANALYSES AND GRADES OF FACE

| Sample No. | Location of Pit | | | | | | Company | Thickness represented | Depth to top of sample in formation |
|---|---|---|---|---|---|---|---|---|---|
| | ¼ | ¼ | ¼ | sec. | T. | R. | | Ft. | Ft. |
| 1 | | SW | NW | 10 | 33 N | 3 E | Ottawa Silica Co., Plant A | 30-35 | 0-5 |
| 2 | | SW | NW | 10 | 33 N | 3 E | Ottawa Silica Co., Plant A | 30-35 | 0-5 |
| 3 | | SW | NW | 10 | 33 N | 3 E | Ottawa Silica Co., Plant A | 30-35 | 0-5 |
| 7 | | NW | SW | 10 | 33 N | 3 E | Ottawa Silica Co., Plant B | 30-35 | 0-5 |
| 9 | | SW | NE | 16 | 33 N | 3 E | Standard Silica Co. | 75 | 0-5 |
| 11 | | SW | SE | 18 | 33 N | 3 E | American Silica Sand Co. | 60 | 0 |
| 13 | | NW | SW | 16 | 33 N | 3 E | Ottawa Silica Co., Plant C | 60 | 0-5 |
| 13a | | NW | SW | 16 | 33 N | 3 E | Ottawa Silica Co., Plant C | 1'2" | 0-5 |
| 14 | | SE | SW | 18 | 33 N | 3 E | American Silica Sand Co. | 50 | 0 |
| 18 | | NW | SE | 9 | 34 N | 4 E | Wedron Silica Co. | 75 | 10-25 |
| 19 | | NW | SE | 9 | 34 N | 4 E | Wedron Silica Co. | 8 | 80-95 |
| 20 | | NW | SE | 9 | 34 N | 4 E | Wedron Silica Co. | 8 | 80-95 |
| 21 | | NW | SE | 9 | 34 N | 4 E | Wedron Silica Co. | 40 | 10-25 |
| 22 | | SW | NE | 17 | 33 N | 3 E | Abandoned | 45 | 0 |
| 23 | | SW | NW | 15 | 33 N | 3 E | Libby, Owens, Ford Glass Co. | 40 | 0-5 |
| 24 | | SW | NW | 15 | 33 N | 3 E | Libby, Owens, Ford Glass Co. | 30 | 0-5 |
| 25 | SW | NE | SE | 13 | 33 N | 2 E | Illinois Silica Sand Co. | 52 | 8 |
| 27 | | NE | SW | 13 | 33 N | 2 E | Bellrose Sand Co. | 55 | 0 |
| 28 | NE | SW | NW | 14 | 33 N | 2 E | American Silica Sand Co. | 25 | 0 |
| 29 | NE | SW | NW | 14 | 33 N | 2 E | American Silica Sand Co. | 25 | 0 |
| 32 | NE | SE | NW | 14 | 33 N | 2 E | American Silica Sand Co. | 25 | 25 |
| 33 | NW | SW | NW | 14 | 33 N | 2 E | American Silica Sand Co. | 62 | 15-20 |
| 34 | | NE | NE | 15 | 33 N | 2 E | American Silica Sand Co. | 30 | 5-10 |
| 35 | | NE | NE | 15 | 33 N | 2 E | American Silica Sand Co. | 30 | 35-40 |
| 36 | | SE | SE | 10 | 33 N | 2 E | American Silica Sand Co. | 55 | 15-20 |
| 38 | | NW | SE | 9 | 33 N | 2 E | American Silica Sand Co. | 65 | 15-20 |
| 39 | | NW | SE | 9 | 33 N | 2 E | American Silica Sand Co. | 35 | 50-55 |
| 40 | | SE | SW | 10 | 33 N | 2 E | George M. Pendergast Co. | 30 | 10-15 |
| 41 | | SE | SW | 10 | 33 N | 2 E | George M. Pendergast Co. | 30 | 40-45 |
| 42 | NW | NW | NW | 16 | 33 N | 3 E | American Silica Sand Co. | 25 | 0 |
| 43 | | NW | SE | 15 | 33 N | 3 E | Bellrose Sand Co. | 50 | 0-5 |
| 45 | | NW | NW | 14 | 33 N | 3 E | Acme Silica Sand Co. | 30 | 0-5 |
| 45a | | SE | NE | 18 | 33 N | 3 E | American Silica Sand Co. | 50 | 0 |
| 45b | | NW | NW | 19 | 33 N | 3 E | American Silica Sand Co. | 70 | 0 |
| 45c | NE | SW | NW | 16 | 34 N | 4 E | American Silica Sand Co. | 30 | 10-25 |

TABLE 1.—*Con't.*

which contains a conspicuous amount of silt or clay, usually more than 10 per cent.

*Cobbly or bouldery sand and gravel.*—A sand or gravel which contains a conspicuous number of cobbles and boulders, usually more than 10 per cent.

Classification of a gravel as fine, medium, or coarse, indicates the predominance of pebbles of those sizes in the gravel portion of the deposit. The description of a material as "medium sandy gravel" indicates it is estimated to contain 50 to 75 per cent sand and the median of the pebbles is between 20 and 40 mm. in diameter. A "medium gravel" would be similar except it would contain less than 50 per cent sand. Due to the variable character of the materials, it is evident that the field estimations are only approximate.

TABLE 2.—OPENINGS OF SIEVES[a]

| Tyler Standard Sieves | | | U. S. Standard Sieves | | |
|---|---|---|---|---|---|
| Mesh | Millimeters | Inches | Sieve No. | Millimeters | Inches |
| 4 | 4.699 | 0.185 | 4 | 4.76 | 0.187 |
| 6 | 3.327 | 0.131 | | | |
| | | | 8 | 2.38 | 0.0937 |
| | | | 10 | 2.00 | 0.0787 |
| 10 | 1.651 | 0.065 | | | |
| | | | 16 | 1.19 | 0.0469 |
| 20 | 0.833 | 0.0328 | 20 | 0.84 | 0.0331 |
| 28 | 0.589 | 0.0232 | 30 | 0.59 | 0.0232 |
| 35 | 0.417 | 0.0164 | 40 | 0.42 | 0.0165 |
| 48 | 0.295 | 0.0116 | 50 | 0.297 | 0.0117 |
| | | | 60 | 0.250 | 0.0098 |
| 65 | 0.208 | 0.0082 | 70 | 0.210 | 0.0083 |
| 100 | 0.147 | 0.0058 | 100 | 0.149 | 0.0059 |
| 150 | 0.104 | 0.0041 | 140 | 0.105 | 0.0041 |
| 200 | 0.074 | 0.0029 | 200 | 0.074 | 0.0029 |
| 270 | 0.053 | 0.0021 | 270 | 0.053 | 0.0021 |

[a]Only the sieves used in analyses given in this report are listed. The sieves are arranged to show corresponding sieves with approximately equivalent openings.

Samples from Pits in St. Peter Sandstone[a]

| Sample No. | Per cent by weight[b] | | | | | | | | | | | | Grades in per cent by weight[c] | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | Sand | | | | | |
| | On 20 | On 28 | On 35 | On 48 | On 65 | On 100 | On 150 | On 200 | On 270 | Thru 270 (Pan) | Total | Clay (−20 microns) | Coarse | Medium | Fine | Very fine | Silt | Clay |
| 1 | .1 | 6.7 | 43.6 | 27.6 | 11.9 | 7.4 | 1.5 | .49 | .31 | .14 | 99.74 | 1.27 | 26 | 57 | 14 | 1 | 1 | 1 |
| 2 | .4 | 18.3 | 52.5 | 19.2 | 4.9 | 2.7 | 1.2 | .5 | .1 | .1 | 99.9 | .58 | 42 | 49 | 7 | 1 | Tr | 1 |
| 3 | .2 | 9.4 | 55.3 | 24.7 | 5.7 | 3.3 | .8 | .3 | .1 | .2 | 100.0 | .64 | 35 | 57 | 6 | 1 | Tr | 1 |
| 7 | .15 | 9.8 | 44.5 | 28.0 | 10.3 | 5.35 | 1.1 | .4 | .1 | .2 | 99.9 | .74 | 30 | 56 | 12 | 1 | Tr | 1 |
| 9 | .05 | 5.1 | 28.0 | 31.7 | 18.2 | 13.5 | 2.6 | .65 | .1 | .2 | 100.1 | 1.6 | 16 | 57 | 23 | 2 | Tr | 2 |
| 11 | .0 | 2.1 | 19.7 | 42.2 | 21.0 | 12.5 | 1.9 | .4 | .1 | .1 | 100.0 | 2.4 | 10 | 62 | 25 | 1 | Tr | 2 |
| 13 | .0 | 2.9 | 28.3 | 29.0 | 16.2 | 14.1 | 4.7 | 2.5 | 1.3 | 1.0 | 100.0 | 3.7 | 14 | 51 | 24 | 6 | 1 | 4 |
| 13a | .1 | 3.8 | 19.4 | 17.5 | 11.3 | 10.7 | 14.7 | 10.3 | 8.1 | 4.2 | 100.0 | 1.95 | 12 | 33 | 23 | 22 | 8 | 2 |
| 14 | . . | 5.6 | 35.0 | 29.7 | 14.0 | 11.2 | 2.3 | 1.0 | .6 | .4 | 99.9 | 4.65 | 20 | 54 | 18 | 2 | 1 | 5 |
| 18 | .05 | 2.20 | 10.9 | 30.4 | 26.4 | 22.3 | 5.1 | 1.4 | .68 | .68 | 100.11 | 1.89 | 8 | 47 | 39 | 3 | 1 | 2 |
| 19 | .0 | .0 | .7 | 15.0 | 35.8 | 40.0 | 6.3 | 1.0 | .6 | .7 | 100.1 | 1.75 | 0 | 31 | 62 | 4 | 1 | 2 |
| 20 | . . | .5 | 3.0 | 23.2 | 33.1 | 34.3 | 4.8 | .7 | .3 | .3 | 100.2 | 1.75 | 2 | 40 | 53 | 3 | Tr | 2 |
| 21 | .2 | 8.4 | 41.0 | 28.9 | 11.9 | 7.2 | 1.6 | .5 | .2 | .1 | 100.0 | 2.3 | 28 | 54 | 14 | 2 | Tr | 2 |
| 22 | .0 | 1.4 | 15.3 | 35.6 | 24.8 | 19.5 | 2.7 | .5 | .1 | .2 | 100.1 | 2.49 | 8 | 55 | 33 | 2 | Tr | 2 |
| 23 | .2 | 10.8 | 40.0 | 28.2 | 11.7 | 6.8 | 1.4 | .6 | .2 | .1 | 100.0 | .83 | 30 | 54 | 14 | 1 | Tr | 1 |
| 24 | .1 | 5.9 | 44.0 | 28.1 | 9.5 | 6.3 | 3.3 | 2.0 | .6 | .1 | 99.9 | 1.41 | 27 | 55 | 13 | 4 | Tr | 1 |
| 25 | .1 | 4.3 | 37.6 | 31.4 | 11.9 | 8.8 | 3.1 | 1.6 | .7 | .4 | 99.9 | 3.4 | 23 | 53 | 17 | 3 | 1 | 3 |
| 27 | .2 | 8.9 | 43.7 | 28.1 | 9.2 | 5.9 | 2.2 | 1.0 | .5 | .4 | 100.1 | 2.2 | 29 | 54 | 12 | 2 | 1 | 2 |
| 28 | .2 | 6.8 | 43.2 | 30.9 | 9.4 | 6.9 | 1.4 | .4 | .2 | .2 | 99.6 | 2.6 | 27 | 55 | 14 | 1 | Tr | 3 |
| 29 | . . | 2.8 | 31.1 | 34.4 | 13.1 | 10.9 | 3.6 | 1.6 | .8 | 1.5 | 99.8 | 3.4 | 18 | 54 | 19 | 4 | 2 | 3 |
| 32 | .0 | .3 | 7.6 | 42.9 | 21.9 | 15.3 | 8.4 | 2.2 | .6 | .9 | 100.1 | 2.1 | 4 | 57 | 29 | 7 | 1 | 2 |
| 33 | .1 | 2.6 | 27.1 | 32.3 | 13.4 | 12.6 | 7.0 | 3.1 | 1.3 | .4 | 99.9 | 3.1 | 16 | 51 | 22 | 7 | 1 | 3 |
| 34 | .2 | 9.5 | 49.8 | 29.6 | 6.8 | 2.9 | .8 | .2 | .1 | .1 | 100.0 | 1.2 | 34 | 57 | 7 | 1 | Tr | 1 |
| 35 | . . | .6 | 8.7 | 31.5 | 18.9 | 20.3 | 13.7 | 3.9 | 1.3 | 1.0 | 99.9 | 3.2 | 5 | 43 | 35 | 12 | 2 | 3 |
| 36 | .5 | 2.4 | 24.2 | 34.2 | 16.4 | 13.6 | 4.7 | 2.2 | 1.2 | 1.0 | 100.4 | 1.9 | 15 | 53 | 23 | 5 | 2 | 2 |
| 38 | . . | 2.2 | 23.6 | 35.2 | 16.5 | 13.9 | 4.9 | 1.9 | .8 | .8 | 99.8 | 1.0 | 14 | 54 | 25 | 5 | 1 | 1 |
| 39 | . . | 1.2 | 12.0 | 28.9 | 20.2 | 19.6 | 10.9 | 4.1 | 1.5 | 1.5 | 99.9 | 2.3 | 7 | 44 | 34 | 11 | 2 | 2 |
| 40 | . . | 2.8 | 31.2 | 36.5 | 13.4 | 9.6 | 3.6 | 1.6 | .6 | .6 | 99.9 | 1.2 | 18 | 58 | 18 | 4 | 1 | 1 |
| 41 | .1 | 2.1 | 21.0 | 28.6 | 14.3 | 14.6 | 10.4 | 5.6 | 2.0 | 1.2 | 99.9 | 2.8 | 12 | 45 | 26 | 12 | 2 | 3 |
| 42 | .05 | 3.8 | 27.9 | 38.8 | 16.7 | 10.1 | 1.8 | .4 | .05 | .3 | 99.9 | 1.1 | 18 | 59 | 20 | 2 | Tr | 1 |
| 43 | .1 | 9.3 | 48.1 | 27.9 | 9.0 | 4.5 | 0.6 | .2 | .1 | .2 | 100.0 | 1.22 | 33 | 55 | 10 | 1 | Tr | 1 |
| 45 | .2 | 7.1 | 36.4 | 27.9 | 14.6 | 10.2 | 1.9 | .7 | .5 | .6 | 100.1 | 1.1 | 25 | 53 | 18 | 2 | 1 | 1 |
| 45a | Tr | 6.0 | 38.0 | 29.8 | 15.0 | 8.1 | 1.7 | .8 | .4 | .2 | 100.0 | 1.7 | 23 | 56 | 17 | 2 | Tr | 2 |
| 45b | .3 | 9.3 | 38.5 | 25.9 | 11.6 | 7.5 | 3.5 | 2.0 | .8 | .6 | 100.0 | 1.5 | 28 | 50 | 15 | 4 | 1 | 2 |
| 45c | .7 | 13.7 | 41.0 | 22.6 | 10.6 | 7.2 | 2.0 | 1.1 | .6 | .5 | 100.0 | 2.3 | 33 | 48 | 13 | 3 | 1 | 2 |
| Average all samples | | | | | | | | | | | | | 20 | 52 | 21 | 4 | 1 | 2 |

Tr = trace, less than .5%.

[a]Lamar, J. E., op. cit., table 10, facing p. 148.
[b]Analyses with Tyler Standard Screen Scale sieves having openings given in table 2.
[c]The grades were obtained by plotting the sieve analyses in cumulative curves and determining the percentages of each grade size by interpolating the size limits given in table 1.

## Table 4.—Sieve Analyses of Outcrop and Well Samples of St. Peter Sandstone

### *Outcrop Sample Set A*

Collected along east side highway in Utica, SE. ¼ SE. ¼ NE. ¼ sec. 8, T. 33 N., R. 2 E. (Utica Twp.), LaSalle quadrangle; base of section at elevation 500 feet is base of St. Peter sandstone; top eroded; 15 feet sampled.

| Sample No. | Depth | Per cent by weight | | |
|---|---|---|---|---|
| | | On No. 40 | On No. 60 | Through No. 60 |
| 1 | Top | 1 | 4 | 95 |
| 2 | 3 | 1 | 12 | 87 |
| 3 | 6 | 6 | 9 | 85 |
| 4 | 9 | 2 | 7 | 91 |
| 5 | 12 | 9 | 23 | 68 |
| 6 | 15 | Tr. | 6 | 94 |

### *Outcrop Sample Set B*

Collected in Reynolds west quarry of American Silica Sand Co., SE. ¼ NW. ¼ SE. ¼ sec. 9, T. 33 N., R. 2 E. (Utica Twp.), Ottawa quadrangle; top of outcrop at elevation of about 590 feet is approximately 15 feet below top of St. Peter sandstone; top eroded and base not reached; 100 feet sampled.

| Sample No. | Depth | Per cent by weight | | |
|---|---|---|---|---|
| | | On No. 40 | On No. 60 | Through No 60 |
| 1 | Top | 9 | 39 | 52 |
| 2 | 5 | 13 | 35 | 52 |
| 3 | 10 | 19 | 41 | 40 |
| 4 | 15 | 28 | 62 | 10 |
| 5 | 20 | 42 | 44 | 14 |
| 6 | 25 | 26 | 39 | 35 |
| 7 | 30 | 32 | 42 | 26 |
| 8 | 35 | 20 | 49 | 31 |
| 9 | 40 | 21 | 53 | 26 |
| 10 | 45 | 12 | 46 | 42 |
| 11 | 50 | 20 | 37 | 43 |
| 12 | 55 | 17 | 52 | 31 |
| 13 | 60 | 34 | 52 | 14 |
| 14 | 65 | 30 | 45 | 25 |
| 15 | 70 | 2 | 35 | 63 |
| 16 | 75 | Tr. | 24 | 76 |
| 17 | 80 | 1 | 70 | 29 |
| 18 | 90 | 2 | 63 | 35 |
| 19 | 95 | 1 | 54 | 45 |
| 20 | 100 | 1 | 45 | 54 |

### *Outcrop Sample Set C*

Collected at NW. corner of Lovers Leap, Starved Rock State Park, SE. ¼ NW. ¼ NW. ¼ sec. 22, T. 33 N., R. 2 E. (Deer Park Twp.), Ottawa quadrangle; top of section at elevation 565 feet is about 10 feet below top of the formation; base not reached and top eroded; 125 feet sampled.

| Sample No. | Depth | Per cent by weight | | |
|---|---|---|---|---|
| | | On No. 40 | On No. 60 | Through No. 60 |
| 1 | Top | 25 | 41 | 34 |
| 2 | 5 | 10 | 51 | 39 |
| 3 | 10 | 21 | 48 | 31 |
| 4 | 15 | 17 | 55 | 28 |
| 5 | 20 | 7 | 29 | 64 |
| 6 | 25 | 26 | 61 | 13 |
| 7 | 30 | 62 | 36 | 6 |
| 8 | 35 | 19 | 43 | 38 |
| 9 | 40 | 32 | 35 | 33 |
| 10 | 45 | 60 | 34 | 6 |
| 11 | 50 | 33 | 53 | 14 |
| 12 | 55 | 46 | 38 | 16 |
| 13 | 60 | 20 | 47 | 33 |
| 14 | 65 | 9 | 49 | 42 |
| 15 | 70 | 20 | 31 | 49 |
| 16 | 75 | 11 | 37 | 52 |
| 17 | 80 | 11 | 51 | 38 |
| 18 | 85 | 5 | 50 | 45 |
| 19 | 90 | 1 | 50 | 49 |
| 20 | 95 | 1 | 47 | 52 |
| 21 | 100 | Tr. | 32 | 68 |

### *Outcrop Sample Set C—Con't.*

| Sample No. | Depth | Per cent by weight | | |
|---|---|---|---|---|
| | | On No. 40 | On No. 60 | Through No. 60 |
| 22 | 105 | 1 | 48 | 51 |
| 23 | 110 | 13 | 45 | 42 |
| 24 | 115 | 2 | 44 | 54 |
| 25 | 120 | Tr. | 4 | 96 |
| 26 | 125 | Tr. | 9 | 91 |

### *Outcrop Sample Set D*

Collected at east end of Buffalo Rock, SW. ¼ NE. ¼ SW. ¼ sec. 17, T. 33 N., R. 3 E. (Ottawa Twp.), Ottawa quadrangle; elevation top of St. Peter sandstone, about 535 feet; samples do not include upper 10 feet of formation which is clayey; base not reached; 50 feet sampled.

| Sample No. | Depth | Per cent by weight | | |
|---|---|---|---|---|
| | | On No. 40 | On No. 60 | Through No. 60 |
| 1 | 10 | 24 | 43 | 33 |
| 2 | 15 | 14 | 54 | 32 |
| 3 | 20 | 35 | 43 | 22 |
| 4 | 25 | 30 | 37 | 33 |
| 5 | 30 | 34 | 38 | 28 |
| 6 | 35 | 41 | 38 | 21 |
| 7 | 40 | 48 | 37 | 15 |
| 8 | 45 | 24 | 38 | 38 |
| 9 | 50 | 60 | 26 | 14 |

### *Well Sample Set No. 444*

Well at Ottawa Silica Co., Plant A, NW. ¼ SW. ¼ NW. ¼ sec. 10, T. 33 N., R. 3 E. (Ottawa Twp.), Ottawa quadrangle; elevation top of well, about 485 feet, 0-5 feet below top of St. Peter sandstone; miscellaneous samples.

| Sample No. | Depth | Per cent by weight | | |
|---|---|---|---|---|
| | | On No. 40 | On No. 60 | Through No. 60 |
| 1 | 67 | 32 | 35 | 33 |
| 2 | 90 | 9 | 44 | 47 |
| 3 | 92 | 10 | 50 | 40 |
| 4 | 117 | 5 | 35 | 60 |

### *Well Sample Set No. 475*

Well at Starved Rock Park, NE. ¼ SE. ¼ NE. ¼ sec. 21, T. 33 N., R. 2 E. (Deer Park Twp.), Ottawa quadrangle; elevation top of well, about 475 feet; represents lower 38 feet of St. Peter sandstone.

| Sample No. | Depth | Per cent by weight | | |
|---|---|---|---|---|
| | | On No. 40 | On No. 60 | Through No. 60 |
| 1 | 5 | 5 | 32 | 63 |
| 2 | 10 | 7 | 30 | 63 |
| 3 | 20 | 1 | 13 | 86 |
| 4 | 30 | 8 | 20 | 72 |
| 5 | 38 | 7 | 22 | 71 |

### *Well Sample Set No. 1070*

Well at Illinois Power and Light Co., Marseilles, NE. cor., SE. ¼ NW. ¼ SE. ¼ sec. 13, T. 33 N., R. 4 E. (Rutland Twp.), Marseilles quadrangle; elevation top of well, about 490 feet; top of St. Peter sandstone at depth of 67 feet; represents all of formation; thickness 243 feet including 15 feet shale at base.

| Sample No. | Depth | Per cent by weight | | |
|---|---|---|---|---|
| | | On No. 40 | On No. 60 | Through No. 60 |
| 13 | 70 | 38 | 45 | 17 |
| 14 | 75 | 42 | 45 | 13 |
| 15 | 80 | 41 | 51 | 8 |
| 16 | 85 | 27 | 57 | 16 |
| 17 | 95 | 28 | 57 | 15 |
| 18 | 100 | 29 | 49 | 22 |
| 19 | 105 | 36 | 49 | 15 |
| 20 | 110 | 34 | 46 | 20 |
| 21 | 115 | 35 | 46 | 19 |
| 22 | 120 | 30 | 43 | 27 |
| 23A | 125 | 28 | 44 | 28 |
| 23B | 130 | 10 | 41 | 49 |
| 24 | 135 | 7 | 32 | 61 |
| 25B | 140 | 4 | 52 | 44 |
| 26 | 145 | 5 | 50 | 45 |
| 27 | 150 | 3 | 33 | 64 |
| 28 | 155 | 4 | 35 | 61 |
| 29 | 160 | 6 | 43 | 51 |
| 30 | 165 | 2 | 31 | 67 |
| 31 | 170 | 1 | 33 | 66 |
| 32B | 175 | 11 | 38 | 51 |
| 33 | 180 | 8 | 33 | 59 |
| 34 | 185 | 14 | 37 | 49 |
| 35 | 190 | 14 | 38 | 48 |
| 36 | 195 | 21 | 40 | 39 |
| 37 | 200 | 29 | 40 | 31 |
| 38 | 205 | 17 | 39 | 44 |
| 39 | 210 | 14 | 38 | 48 |
| 40 | 220 | 5 | 26 | 69 |
| 41 | 225 | 6 | 29 | 65 |
| 42 | 235 | 7 | 27 | 66 |
| 43 | 240 | 9 | 29 | 62 |
| 44 | 245 | 5 | 29 | 66 |
| 45 | 250 | 5 | 35 | 60 |
| 46 | 255 | 3 | 29 | 68 |
| 47 | 260 | 4 | 20 | 76 |
| 48 | 265 | 4 | 36 | 60 |
| 49 | 270 | 1 | 18 | 81 |
| 50A | 275 | 1 | 21 | 78 |
| 51 | 280 | 2 | 16 | 82 |
| 52 | 285 | 12 | 39 | 49 |
| 53 | 290 | 6 | 26 | 68 |
| 54 | 295 | 8 | 28 | 64 |

### *Well Sample Set No. 1101*

Peru City Well, NE. ¼ NE. ¼ NE. ¼ sec. 20, T. 33 N., R. 1 E. (Peru Twp.), LaSalle quadrangle; elevation top of well, about 470 feet; depth to top of St. Peter sandstone, 1365 feet; represents all of formation; thickness 135 feet.

| Sample No. | Depth | Per cent by weight | | |
|---|---|---|---|---|
| | | On No. 40 | On No. 60 | Through No. 60 |
| 270 | 1370 | 60 | 32 | 8 |
| 271 | 1375 | 42 | 41 | 17 |
| 272 | 1380 | 27 | 28 | 45 |
| 273 | 1385 | 35 | 48 | 17 |
| 274 | 1390 | 17 | 47 | 36 |
| 275 | 1395 | 16 | 48 | 36 |
| 276 | 1400 | 27 | 52 | 21 |
| 277 | 1405 | 17 | 42 | 41 |
| 278 | 1410 | 16 | 45 | 39 |
| 279 | 1415 | 1 | 32 | 67 |
| 280 | 1420 | 8 | 43 | 49 |
| 281 | 1425 | 9 | 42 | 49 |
| 282 | 1430 | 7 | 49 | 44 |
| 283 | 1435 | 7 | 51 | 42 |
| 284 | 1440 | 11 | 49 | 40 |
| 285 | 1445 | 11 | 46 | 43 |
| 286 | 1450 | 10 | 44 | 46 |
| 287 | 1455 | 12 | 50 | 38 |
| 288 | 1460 | 7 | 39 | 54 |
| 289 | 1465 | 13 | 27 | 60 |
| 290 | 1470 | 9 | 25 | 66 |
| 291 | 1475 | 11 | 36 | 53 |
| 292 | 1480 | 7 | 29 | 64 |
| 293 | 1485 | 10 | 28 | 62 |
| 294 | 1490 | 10 | 24 | 66 |
| 295 | 1495 | 12 | 25 | 63 |
| 296 | 1500 | 10 | 26 | 64 |

### *Well Sample Set No. 1104*

Ottawa City Well, NE. ¼ NE. ¼ SE. ¼ sec. 14, T. 33 N., R. 3 E. (South Ottawa Twp.), Ottawa quadrangle; elevation top of well, about 580 feet; top of St. Peter sandstone at depth of 115 feet; represents all of formation; thickness 157 feet.

| Sample No. | Depth | Per cent by weight | | |
|---|---|---|---|---|
| | | On No. 40 | On No. 60 | Through No. 60 |
| 9 | 120 | 38 | 35 | 26 |
| 10 | 125 | 50 | 34 | 16 |
| 11 | 130 | 46 | 34 | 20 |
| 12 | 135 | 38 | 36 | 26 |
| 13 | 140 | 41 | 32 | 27 |
| 14 | 145 | 44 | 32 | 24 |
| 15 | 150 | 47 | 33 | 20 |
| 16 | 155 | 48 | 34 | 18 |
| 17 | 160 | 46 | 34 | 20 |
| 18 | 165 | 51 | 34 | 15 |
| 19 | 170 | 53 | 32 | 15 |
| 20 | 180 | 39 | 39 | 22 |
| 21 | 190 | 41 | 46 | 13 |
| 22 | 200 | 47 | 43 | 10 |
| 23 | 215 | 11 | 51 | 38 |
| 24 | 225 | 21 | 27 | 52 |
| 25 | 235 | 12 | 28 | 60 |
| 26 | 245 | 4 | 20 | 76 |
| 27 | 255 | 5 | 23 | 72 |
| 28 | 265 | 3 | 11 | 86 |
| 29 | 272 | 6 | 24 | 70 |

### *Well Sample Set No. 1232*

Ransom City Well, NW. ¼ NW. ¼ SE. ¼ sec. 16, T. 31 N., R. 5 E. (Allen Twp.); elevation top of well, about 700 feet; top of St. Peter sandstone at depth of 675 feet; base not reached; thickness 156 feet.

| Sample No. | Depth | Per cent by weight | | |
|---|---|---|---|---|
| | | On No. 40 | On No. 60 | Through No. 60 |
| 115 | 680 | >25 | | |
| 116 | 685 | 5 | 30 | 65 |
| 117 | 690 | Tr. | 18 | 82 |
| 118 | 695 | 2 | 35 | 63 |
| 119 | 700 | 1 | 48 | 51 |
| 120 | 705 | 2 | 42 | 56 |
| 121 | 710 | 3 | 36 | 61 |
| 122 | 715 | 1 | 19 | 80 |
| 123 | 720 | 1 | 20 | 79 |
| 124 | 725 | 1 | 18 | 81 |
| 125 | 730 | 1 | 26 | 73 |
| 126 | 735 | 2 | 24 | 74 |
| 127 | 740 | 2 | 24 | 74 |
| 128 | 745 | 3 | 27 | 70 |
| 130 | 755 | 4 | 29 | 67 |
| 132 | 765 | 5 | 29 | 66 |
| 134 | 775 | 3 | 22 | 75 |
| 136 | 785 | 3 | 23 | 74 |
| 138 | 795 | 3 | 20 | 77 |
| 140 | 805 | 8 | 25 | 67 |
| 141 | 810 | 3 | 23 | 74 |
| 142 | 815 | 5 | 31 | 64 |
| 143 | 831 | 1 | 10 | 89 |

### *Well Sample Set No. 1259*

Ottawa City Well 8B, E. ½ SW. ¼ SW. ¼ sec. 1, T. 33 N., R. 3 E. (Ottawa Twp.), Ottawa quadrangle; elevation top of well, about 480 feet, is also top of St. Peter sandstone; represents all of formation; thickness 165 feet.

| Sample No. | Depth | Per cent by weight | | |
|---|---|---|---|---|
| | | On No. 40 | On No. 60 | Through No. 60 |
| 1 | 30 | 33 | 35 | 32 |
| 2 | 35 | 34 | 35 | 31 |
| 3 | 40 | 22 | 51 | 27 |
| 4 | 45 | 17 | 53 | 30 |
| 5 | 50 | 29 | 40 | 31 |
| 6 | 55 | 34 | 38 | 28 |
| 7 | 60 | 35 | 40 | 25 |
| 8 | 65 | 31 | 39 | 30 |
| 9 | 70 | 35 | 40 | 25 |
| 10 | 75 | 34 | 41 | 25 |
| 11 | 80 | 33 | 41 | 26 |
| 12 | 85 | 35 | 43 | 22 |
| 13 | 90 | 3 | 53 | 44 |
| 14 | 95 | 4 | 57 | 39 |
| 15 | 100 | 9 | 54 | 37 |
| 16 | 105 | 7 | 55 | 38 |
| 17 | 110 | 10 | 57 | 33 |
| 18 | 115 | 10 | 62 | 28 |
| 19 | 120 | 3 | 57 | 40 |
| 20 | 125 | 3 | 55 | 42 |
| 21 | 130 | 6 | 57 | 37 |
| 22 | 135 | 6 | 64 | 30 |

### *Well Sample Set No. 1259—Con't.*

| Sample No. | Depth | Per cent by weight | | |
|---|---|---|---|---|
| | | On No. 40 | On No. 60 | Through No. 60 |
| 23 | 140 | 7 | 58 | 35 |
| 24 | 145 | 6 | 56 | 38 |
| 25 | 150 | 9 | 45 | 46 |
| 26 | 155 | 11 | 42 | 47 |
| 27 | 160 | 5 | 43 | 52 |
| 28 | 165 | 5 | 33 | 62 |

### *Well Sample Set No. 1319*

Well at Civilian Conservation Corps Camp, NE. corner SW. ¼ SW. ¼ sec. 23, T. 33 N., R. 2 E. (Deer Park Twp.); elevation top of well, about 610 feet; depth to top of St. Peter sandstone, 35 feet; represents all of formation; thickness 140 feet.

| Sample No. | Depth | Per cent by weight | | |
|---|---|---|---|---|
| | | On No. 40 | On No. 60 | Through No. 60 |
| 7 | 40 | 17 | 55 | 28 |
| 8 | 45 | 17 | 55 | 28 |
| 9 | 50 | 17 | 57 | 26 |
| 10 | 55 | 17 | 57 | 26 |
| 11 | 60 | 22 | 47 | 31 |
| 12 | 65 | 26 | 44 | 30 |
| 13 | 70 | 32 | 43 | 25 |
| 14 | 75 | 31 | 45 | 24 |
| 15 | 80 | 37 | 39 | 24 |
| 16 | 85 | 34 | 41 | 25 |
| 17 | 90 | 36 | 41 | 23 |
| 18 | 95 | 35 | 41 | 24 |
| 19 | 100 | 44 | 37 | 19 |
| 20 | 105 | 43 | 39 | 18 |
| 21 | 110 | 34 | 35 | 31 |
| 22 | 115 | 33 | 34 | 33 |
| 23 | 120 | 4 | 50 | 46 |
| 24 | 125 | 3 | 48 | 49 |
| 25 | 130 | 4 | 52 | 44 |
| 26 | 135 | 3 | 34 | 63 |
| 27 | 140 | 6 | 42 | 52 |
| 28 | 145 | 5 | 42 | 53 |
| 29 | 150 | 14 | 42 | 44 |
| 30 | 155 | 20 | 45 | 35 |
| 31 | 160 | 38 | 27 | 35 |
| 32 | 165 | 47 | 27 | 26 |
| 33 | 170 | 41 | 26 | 33 |

Table 5.—Sieve Analyses of Pennsylvanian Sandstones

| Sample No. | Sandstone | Location | | | | | | | Soluble in HCl (per cent) | Grade sizes[a] (per cent) | | | | | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | Sand | | | Silt | Clay | |
| | | ¼ | ¼ | ¼ | sec. | T. | R. | Quadrangle | | Med. | Fine | V.Fine | | | |
| 1 | Pleasantview | NE | SW | NW | 20 | 33 N | 7 E | Morris | 9 | Tr. | 14 | 49 | 35 | 2 | |
| 2 | Pleasantview | SE | NW | NE | 24 | 33 N | 4 E | Marseilles | 19 | Tr. | 22 | 44 | 29 | 5 | |
| 3 | Pleasantview | SE | SE | NW | 21 | 34 N | 4 E | Ottawa | 16 | | 2 | 25 | 61 | 12 | [a]Limiting sizes of grades |
| 4 | Pleasantview | NE | SE | NE | 31 | 34 N | 4 E | Ottawa | 54 | | | | 69 | 31 | are given in table 1 of |
| 5 | Pleasantview | SW | NW | NE | 26 | 33 N | 3 E | Ottawa | 16 | | 2 | 39 | 52 | 7 | Appendix D. |
| 6 | Pleasantview | NW | NE | SW | 10 | 32 N | 2 E | Ottawa | 40 | | Tr. | 19 | 59 | 22 | |
| 7 | Pleasantview | NE | SE | SW | 8 | 32 N | 2 E | LaSalle | 18 | | Tr. | 15 | 69 | 16 | |
| 8 | Pleasantview | NE | SE | NE | 31 | 33 N | 2 E | LaSalle | 25 | | Tr. | 12 | 72 | 16 | |
| 9 | Pleasantview | NE | NE | NE | 3 | 33 N | 1 E | LaSalle | 25 | | 2 | 25 | 70 | 13 | |
| 10 | Pleasantview | SW | SE | NE | 34 | 34 N | 1 E | LaSalle | 8 | | 2 | 21 | 70 | 7 | |
| 11 | Vermilionville | SE | SW | NW | 20 | 33 N | 7 E | Morris | 8 | 21 | 62 | 5 | 9 | 3 | |
| 12 | Vermilionville | SE | SE | SE | 31 | 33 N | 2 E | LaSalle | 19 | | 8 | 45 | 41 | 6 | |
| 13 | Vermilionville | NW | SW | SE | 21 | 33 N | 3 E | Ottawa | 17 | 2 | 48 | 26 | 20 | 4 | |
| 14 | Vermilionville | NW | NE | SW | 28 | 33 N | 3 E | Ottawa | 1 | 10 | 88 | 5 | 6 | 1 | |
| 15 | Vermilionville | NE | SW | NW | 13 | 33 N | 4 E | Marseilles | 11 | 2 | 56 | 20 | 18 | 4 | |
| 16 | Vermilionville | SE | SE | NE | 21 | 33 N | 5 E | Marseilles | 5 | 2 | 55 | 22 | 17 | 4 | |
| 17 | Vermilionville | NE | NW | NW | 32 | 32 N | 3 E | Streator | 3 | 2 | 56 | 24 | 15 | 3 | |
| 18 | Vermilionville | SW | NW | NW | 15 | 31 N | 3 E | Streator | 6 | | 20 | 34 | 40 | 6 | |
| 19 | Vermilionville | NE | SE | NE | 31 | 33 N | 2 E | LaSalle | 5 | | 28 | 40 | 27 | 5 | |
| 20 | Vermilionville | NE | NW | NE | 7 | 32 N | 2 E | LaSalle | 28 | | | 12 | 68 | 20 | |
| 21 | Vermilionville | SW | NE | SW | 18 | 33 N | 4 E | Ottawa | 1 | 5 | 69 | 13 | 9 | 3 | |
| 22 | Vermilionville | SW | NW | NW | 30 | 33 N | 5 E | Marseilles | 2 | Tr. | 40 | 34 | 22 | 4 | |
| 23 | Vermilionville | SE | NW | NE | 10 | 33 N | 6 E | Marseilles | 7 | 3 | 59 | 19 | 15 | 4 | |
| 24 | Vermilionville | NW | SE | SE | 19 | 33 N | 6 E | Marseilles | 3 | Tr. | 62 | 24 | 11 | 3 | |
| 25 | Vermilionville | NE | SE | SW | 8 | 32 N | 2 E | LaSalle | 7 | 1 | 61 | 13 | 11 | 4 | |
| 26 | Vermilionville | NE | NW | NE | 7 | 32 N | 2 E | LaSalle | 25 | | | 9 | 70 | 21 | |
| 27 | Vermilionville | NE | SE | NE | 31 | 33 N | 2 E | LaSalle | 5 | | 20 | 42 | 30 | 8 | |
| 28 | Vermilionville | SE | SW | NW | 20 | 33 N | 7 E | Morris | 8 | 7 | 73 | 6 | 11 | 3 | |
| 29 | Vermilionville | NE | SE | NE | 1 | 32 N | 7 E | Morris | 37 | 6 | 56 | 15 | 20 | 3 | |
| 30 | Vermilionville | NE | SE | NE | 1 | 32 N | 7 E | Morris | 43 | 4 | 53 | 17 | 23 | 3 | 1 foot above 29 |
| 31 | Vermilionville | NE | SE | NE | 1 | 32 N | 7 E | Morris | 5 | 6 | 66 | 11 | 14 | 3 | 2 feet above 29 |
| 32 | Vermilionville | NE | SE | NE | 1 | 32 N | 7 E | Morris | 2 | 10 | 67 | 8 | 12 | 3 | 3 feet above 29 |
| 33 | Vermilionville | NE | SE | NE | 1 | 32 N | 7 E | Morris | 40 | | 40 | 27 | 27 | 6 | 50 feet south of 30-32 |
| 34 | Vermilionville | NE | SE | NE | 1 | 32 N | 7 E | Morris | 40 | 1 | 40 | 27 | 27 | 5 | 1 foot above 33 |
| 35 | Vermilionville | NE | SE | NE | 1 | 32 N | 7 E | Morris | 2 | 4 | 57 | 20 | 15 | 4 | 2 feet above 33 |
| 36 | Vermilionville | NE | SE | NE | 1 | 32 N | 7 E | Morris | 2 | 3 | 69 | 13 | 13 | 3 | 3 feet above 33 |
| 37 | Unit 53 | NE | SE | SE | 2 | 30 N | 3 E | Streator | 5 | Tr. | 48 | 31 | 16 | 5 | |
| 38 | Unit 62 | NW | SW | NW | 18 | 30 N | 4 E | Streator | 4 | 8 | 59 | 13 | 15 | 5 | |
| 39 | Unit 62 | NW | SW | NW | 18 | 30 N | 4 E | Streator | 3 | 6 | 57 | 15 | 17 | 5 | 2 feet above 38 |
| 40 | Unit 62 | NW | SW | NW | 18 | 30 N | 4 E | Streator | 2 | 7 | 60 | 11 | 17 | 5 | 6 feet above 38 |
| 41 | Unit 62 | NW | SW | NW | 18 | 30 N | 4 E | Streator | 2 | 8 | 62 | 9 | 16 | 5 | 11 feet above 38 |
| 42 | Unit 62 | NW | NE | SE | 31 | 33 N | 2 E | LaSalle | 14 | 3 | 53 | 13 | 22 | 9 | |
| 43 | Unit 62 | SW | SW | SW | 12 | 33 N | 1 E | LaSalle | 6 | 1 | 37 | 25 | 29 | 8 | |

TABLE 6.—SIEVE ANALYSES AND

(Tests by Illinois State

| No. | Location | | | | | | | Thickness Sampled | Per cent wear Sand | Specific Gravity | | Absorption Gravel | Wt. per cu. ft. Aggregate |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | ¼ | ¼ | ¼ | sec. | T. | R. | Quadrangle | | | Sand | Gravel | | |
| DX-11 | SW. | NW. | NW. | 9 | 33 N. | 4 E. | Ottawa | 12 | ...... | ...... | ...... | ........ | ........ |
| J-8 | NW. | NE. | SW. | 19 | 30 N. | 4 E. | Streator | 20 | 4.2 | 2.69 | 2.61 | 2.0 | 119.5 |
| J-16 | SW. | NW. | NW. | 20 | 31 N. | 4 E. | Streator | 9 | 8.0 | 2.65 | 2.48 | 3.73 | 113.4 |
| J-17 | NE. | SW. | SE. | 23 | 32 N. | 2 E. | Streator | 14 | 4.6 | 2.69 | 2.61 | 1.8 | 116.0 |
| ML-130 | SW. | SE. | SW. | 15 | 33 N. | 3 E. | Ottawa | ........ | 3.8 | ...... | ...... | ........ | ........ |
| ML-132 | SW. | NW. | NW. | 20 | 31 N. | 4 E. | Streator | 25 | 5.0 | ...... | ...... | ........ | ........ |
| ML-133 | SW. | NW. | NE. | 5 | 34 N. | 4 E. | Ottawa | 10 | 3.0 | ...... | ...... | ........ | ........ |
| ML-141 | SW. | NW. | SE. | 15 | 32 N. | 2 E. | Streator | 15 | 3.8 | ...... | ...... | ........ | ........ |
| ML-176 | NE. | SE. | SW. | 29 | 35 N. | 5 E. | Marseilles | 20 | 4.6 | ...... | ...... | ........ | ........ |
| ML-177 | SW. | SW. | SW. | 21 | 35 N. | 5 E. | Marseilles | 12 | 7.6 | ...... | ...... | ........ | ........ |
| ML-181 | | SE. | NE. | 31 | 34 N. | 4 E. | Ottawa | 30 | 4.0 | ...... | ...... | ........ | ........ |
| ML-182 | NE. | NE. | SE. | 3 | 34 N. | 4 E. | Marseilles | 16 | 3.4 | ...... | ...... | ........ | ........ |
| ML-192 | SW. | SW. | NE. | 26 | 32 N. | 2 E. | Streator | 9 | 6.0 | ...... | ...... | ........ | ........ |
| ML-193 | NW. | NE. | SW. | 29 | 33 N. | 5 E. | Marseilles | 20 | 3.4 | ...... | ...... | ........ | ........ |
| ML-194 | SE. | SW. | SE. | 15 | 33 N. | 3 E. | Ottawa | 15 | 5.4 | ...... | ...... | ........ | ........ |
| ML-195 | SW. | NW. | NW. | 8 | 33 N. | 6 E. | Marseilles | 11 | 5.8 | ...... | ...... | ........ | ........ |
| ML-196 | NE. | NW. | SW. | 22 | 33 N. | 5 E. | Marseilles | 20 | 4.6 | ...... | ...... | ........ | ........ |
| ML-198 | NE. | SW. | NE. | 16 | 32 N. | 2 E. | Streator | 30 | 3.4 | ...... | ...... | ........ | ........ |
| ML-199[f] | NE. | SE. | NW. | 21 | 33 N. | 5 E. | Marseilles | 20 | 2.6 | ...... | ...... | ........ | ........ |
| ML-200[g] | NE. | SE. | NW. | 21 | 33 N. | 5 E. | Marseilles | 12 | 9.2 | ...... | ...... | ........ | ........ |
| W-1 | NE. | NW. | SE. | 30 | 35 N. | 5 E. | Marseilles | 8 | 3.2 | 2.70 | 2.63 | 1.8 | 117.5 |
| W-2 | SW. | SE. | NW. | 36 | 35 N. | 4 E. | Marseilles | 7 | 2.6 | 2.66 | 2.54 | 2.6 | 126.2 |

(Con't. on pp. 352-353.)

Physical Tests of Sand and Gravel
Division of Highways)

| Per[a] cent Passing Retained | Sieve Analysis | | | | | | | | | | | | | | | | | | | | No. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2½" | 2" | 1¾" | 1½" | 1¼" | 1" | ¾" | ½" | ⅜" | 4 | 8 | 10 | 16 | 20 | 30 | 40 | 50 | 100 | 200 | Clay[i] | |
| Passing | .... | .... | .... | .... | .... | 60 | .... | .... | .... | 35 | .... | .... | .... | 14 | .... | .... | .... | ... | ... | ..... | DX-11 |
| Retained | .... | .... | .... | .... | .... | 40 | .... | .... | .... | 25 | .... | .... | .... | 20 | .... | .... | .... | ... | ... | ..... | |
| Passing | .... | 100 | .... | 96 | .... | 96 | 91 | 88 | 84 | 75 | 61 | .... | 39 | 28 | .... | .... | 6 | 1 | ... | 4.3 | J-8 |
| Retained | .... | 0 | .... | 4 | .... | 0 | 5 | 3 | 4 | 9 | 14 | .... | 22 | 11 | .... | .... | 22 | 5 | ... | ..... | |
| Passing | .... | 100 | .... | 98 | .... | 94 | 92 | 89 | 84 | 71 | 53 | .... | 33 | 24 | .... | .... | 5 | 1 | ... | 12.9 | J-16 |
| Retained | .... | 0 | .... | 2 | .... | 4 | 2 | 3 | 5 | 13 | 18 | .... | 20 | 9 | .... | .... | 19 | 4 | ... | ..... | |
| Passing | .... | 93 | .... | 90 | .... | 83 | 78 | 72 | 65 | 47 | 30 | .... | 15 | 10 | .... | .... | 2 | 1 | ... | 5.0 | J-17 |
| Retained | .... | 7 | .... | 3 | .... | 7 | 5 | 6 | 7 | 18 | 17 | .... | 15 | 5 | .... | .... | 8 | 1 | ... | ..... | |
| Passing | [b]91 | 89 | 88 | 87 | 85 | 81 | 75 | 64 | 59 | 49 | 30 | 23 | 14 | 12 | 9 | 7 | 5 | 2 | 1 | 6.7 | ML-130 |
| Retained | 4 | 2 | 1 | 1 | 2 | 4 | 6 | 11 | 5 | 10 | 19 | 7 | 9 | 2 | 3 | 2 | 2 | 3 | 1 | ..... | |
| Passing | .... | 100 | 97 | 94 | 92 | 91 | 87 | 81 | 74 | 63 | 40 | 29 | 15 | 10 | 7 | 5 | 3 | 2 | 1 | 5.8 | ML-132 |
| Retained | .... | 0 | 3 | 3 | 2 | 1 | 4 | 6 | 7 | 11 | 23 | 11 | 14 | 5 | 3 | 2 | 2 | 1 | 1 | ..... | |
| Passing | 100 | 95 | 93 | 91 | 88 | 84 | 81 | 75 | 69 | 62 | 47 | 40 | 21 | 13 | 6 | 5 | 4 | 3 | 2 | 4.1 | ML-133 |
| Retained | 0 | 5 | 2 | 2 | 3 | 4 | 3 | 6 | 6 | 7 | 15 | 7 | 19 | 8 | 7 | 1 | 1 | 1 | 1 | ..... | |
| Passing | .... | 100 | 98 | .... | 97 | 95 | 93 | 88 | 81 | 66 | 40 | 30 | 15 | 12 | 6 | 5 | 4 | 3 | 2 | 5.1 | ML-141 |
| Retained | .... | 0 | 2 | .... | 1 | 2 | 2 | 5 | 7 | 15 | 26 | 10 | 15 | 3 | 6 | 1 | 1 | 1 | 1 | ..... | |
| Passing | 100 | 97 | 95 | 92 | 89 | 86 | 81 | 75 | 70 | 64 | 52 | 48 | 39 | 35 | 32 | 17 | 6 | 3 | 2 | 3.7 | ML-176 |
| Retained | 0 | 3 | 2 | 3 | 3 | 3 | 5 | 6 | 5 | 6 | 12 | 4 | 9 | 4 | 3 | 15 | 11 | 3 | 1 | ..... | |
| Passing | .... | .... | .... | .... | 100 | 99 | 97 | 90 | 83 | 72 | 53 | 46 | 35 | 28 | 17 | 10 | 4 | 2 | 1 | 3.9 | ML-177 |
| Retained | .... | .... | .... | .... | 0 | 1 | 2 | 7 | 7 | 11 | 19 | 7 | 11 | 7 | 11 | 7 | 6 | 2 | 1 | ..... | |
| Passing | .... | .... | 100 | 98 | 97 | 95 | 92 | 85 | 75 | 62 | 46 | 38 | 27 | 24 | 18 | 13 | 7 | 3 | 2 | 3.1 | ML-181 |
| Retained | .... | .... | 0 | 2 | 1 | 2 | 3 | 7 | 10 | 13 | 16 | 8 | 11 | 3 | 6 | 5 | 6 | 4 | 1 | ..... | |
| Passing | [c]95 | 93 | 91 | 81 | 77 | 72 | 68 | 58 | 51 | 40 | 30 | 27 | 20 | 18 | 14 | 9 | 4 | 1 | .. | 1.9 | ML-182 |
| Retained | 5 | 2 | 2 | 10 | 4 | 5 | 4 | 10 | 7 | 11 | 10 | 3 | 7 | 2 | 4 | 5 | 5 | 3 | 1 | ..... | |
| Passing | .... | .... | .... | .... | 100 | 99 | 98 | 94 | 90 | 82 | 63 | 54 | 38 | 31 | 16 | 8 | 3 | 1 | ... | 4.6 | ML-192 |
| Retained | .... | .... | .... | .... | ..0 | 1 | 1 | 4 | 4 | 8 | 19 | 9 | 16 | 7 | 15 | 8 | 5 | 2 | 1 | ..... | |
| Passing | 100 | 98 | 96 | 95 | 93 | 92 | 90 | 84 | 77 | 67 | 49 | 43 | 34 | 31 | 26 | 17 | 7 | 2 | 1 | 2.6 | ML-193 |
| Retained | 0 | 2 | 2 | 1 | 2 | 1 | 2 | 6 | 7 | 10 | 18 | 6 | 9 | 3 | 5 | 9 | 10 | 5 | 1 | ..... | |
| Passing | 100 | 95 | 91 | 89 | 87 | 82 | 74 | 65 | 60 | 47 | 36 | 29 | 18 | 15 | 9 | 7 | 4 | 2 | 1 | 7.4 | ML-194 |
| Retained | 0 | 5 | 4 | 2 | 2 | 5 | 8 | 9 | 5 | 13 | 11 | 7 | 11 | 3 | 6 | 2 | 3 | 2 | 1 | ..... | |
| Passing | 100 | 97 | 95 | 94 | 91 | 90 | 88 | 81 | 73 | 64 | 45 | 38 | 26 | 17 | 7 | 3 | 2 | 1 | ... | 4.4 | ML-195 |
| Retained | 0 | 3 | 2 | 1 | 3 | 1 | 2 | 7 | 8 | 9 | 19 | 7 | 12 | 9 | 10 | 4 | 1 | 1 | 1 | ..... | |
| Passing | .... | [d]97 | .... | .... | .... | .... | .... | 96 | 95 | 93 | 81 | 68 | 36 | 24 | 11 | 5 | 3 | 2 | 1 | 4.3 | ML-196 |
| Retained | .... | 3 | .... | .... | .... | .... | .... | 1 | 1 | 2 | 12 | 13 | 32 | 12 | 13 | 6 | 2 | 1 | 1 | ..... | |
| Passing | .... | 100 | 98 | 95 | 94 | 90 | 85 | 81 | 75 | 66 | 48 | 41 | 30 | 23 | 14 | 8 | 4 | 2 | ... | 3.4 | ML-198 |
| Retained | .... | 0 | 2 | 3 | 1 | 4 | 5 | 4 | 6 | 9 | 18 | 7 | 11 | 7 | 9 | 6 | 4 | 2 | 2 | ..... | |
| Passing | .... | [e]98 | 96 | 95 | 93 | 91 | 90 | 84 | 78 | 73 | 64 | 60 | 55 | 44 | 28 | 16 | 8 | 3 | 1 | 0.4 | ML-199[f] |
| Retained | .... | 2 | 2 | 1 | 2 | 2 | 1 | 6 | 6 | 5 | 9 | 4 | 5 | 11 | 16 | 12 | 8 | 5 | 2 | ..... | |
| Passing | .... | 100 | 98 | 95 | 93 | 89 | 83 | 72 | 61 | 53 | 44 | 39 | 31 | 28 | 22 | 16 | 8 | 3 | 2 | 7.1 | ML-200[g] |
| Retained | .... | 0 | 2 | 3 | 2 | 4 | 6 | 11 | 11 | 8 | 9 | 5 | 8 | 3 | 6 | 6 | 8 | 5 | 1 | ..... | |
| Passing | .... | 100 | .... | 97 | .... | 90 | 89 | 83 | 74 | 44 | 17 | .... | 7 | 5 | .... | .... | 1 | ... | ... | 1.9 | W-1 |
| Retained | .... | 0 | .... | 3 | .... | 7 | 1 | 6 | 9 | 30 | 27 | .... | 10 | 2 | .... | .... | 4 | ... | 1 | ..... | |
| Passing | .... | .... | .... | 100 | .... | 92 | 82 | 70 | 58 | 41 | 28 | .... | 20 | 16 | .... | .... | 2 | ... | ... | 1.8 | W-2 |
| Retained | .... | .... | .... | 0 | .... | 8 | 10 | 12 | 12 | 17 | 13 | .... | 8 | 4 | .... | .... | 14 | ... | 2 | ..... | |

[a]Passing = total per cent passing the sieve.
Retained = per cent retained on the sieve and passing the next larger sieve.
[b]4-inch, 100 per cent passing; 3-inch, 95 per cent passing and 5 per cent retained.
[c]3-inch, 100 per cent passing.
[d]3-inch, 100 per cent passing.
[e]4-inch, 100 per cent passing.
[f]Upper.
[g]Lower.
[i]Includes silt.

Table 6.—Sieve Analyses and Physical

| No. | Location | | | | | | | Thickness Sampled | Per cent wear Sand | Specific Gravity | | Absorption Gravel | Wt. per cu. ft. Aggregate |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | ¼ | ¼ | ¼ | sec. | T. | R. | Quadrangle | | | Sand | Gravel | | |
| W-3 | NE. | SE. | SE. | 35 | 35 N. | 4 E. | Marseilles | 20 | 4.2 | 2.67 | 2.59 | 1.8 | 128.6 |
| W-4 | NE. | NW. | SE. | 9 | 34 N. | 4 E. | Ottawa | 6 | 3.4 | 2.67 | 2.58 | 2.2 | 130.1 |
| W-5 | SW. | SW. | NW. | 32 | 34 N. | 4 E. | Ottawa | 8 | 6.0 | 2.66 | 2.54 | 2.6 | 118.6 |
| W-6 | SW. | SW. | NE. | 20 | 35 N. | 5 E. | Marseilles | 8 | 4.0 | 2.70 | 2.62 | 1.7 | 131.0 |
| W-7 | NE. | SE. | SW. | 29 | 35 N. | 5 E. | Marseilles | 15 | 3.0 | 2.66 | 2.56 | 2.5 | 120.3 |
| W-8 | NW. | SW. | NW. | 18 | 34 N. | 5 E. | Marseilles | 10 | 6.4 | 2.66 | 2.50 | 3.7 | 109.7 |
| W-9 | NE. | NW. | SW. | 22 | 33 N. | 5 E. | Marseilles | 11 | 6.6 | 2.65 | ....... | ........ | 99.4 |
| W-10 | NW. | NW. | SE. | 15 | 34 N. | 6 E. | Marseilles | 6 | 6.0 | 2.69 | 2.59 | 2.1 | 113.5 |
| W-11 | SW. | SW. | NE. | 31 | 33 N. | 6 E. | Marseilles | 7 | 5.6 | 2.66 | 2.51 | 3.0 | 110.5 |
| W-12 | SW. | SW. | NW. | 36 | 33 N. | 5 E. | Marseilles | 12 | 5.8 | 2.66 | 2.54 | 2.9 | 112.0 |
| W-13 | NE. | NW. | NW. | 8 | 32 N. | 5 E. | Marseilles | 8 | 7.0 | 2.65 | 2.54 | 2.9 | 103.5 |
| W-14 | NW. | NE. | SE. | 20 | 33 N. | 3 E. | Ottawa | 7 | 6.4 | 2.65 | 2.40 | 3.5 | 120.5 |
| W-16 | NW. | SW. | SW. | 4 | 33 N. | 4 E. | Ottawa | 10 | 13.2 | 2.77 | 2.41 | 4.1 | 124.0 |
| W-17 | NW. | NW. | NW. | 6 | 33 N. | 4 E. | Ottawa | 10 | 6.4 | 2.71 | 2.54 | 2.7 | 125.0 |
| W-18 | NW. | SW. | SE. | 10 | 33 N. | 2 E. | Ottawa | 15 | 4.2 | 2.75 | 2.52 | 2.7 | 117.0 |
| W-19[h] | SW. | SE. | SW. | 26 | 33 N. | 5 E. | Marseilles | 11 | 6.4 | 2.70 | 2.62 | 1.9 | 127.9 |
| W-20 | SW. | NW. | NW. | 8 | 33 N. | 6 E. | Marseilles | 18 | 4.2 | 2.73 | ....... | ........ | 116.0 |
| W-80 | NW. | NW. | NW. | 36 | 33 N. | 5 E. | Marseilles | 30 | ...... | ...... | ....... | ........ | ........ |

Tests of Sand and Gravel—*Concluded*

| Per[a] cent Passing Retained | Sieve Analysis | | | | | | | | | | | | | | | | | | | | No. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2½" | 2" | 1¾" | 1½" | 1¼" | 1" | ¾" | ½" | ⅜" | 4 | 8 | 10 | 16 | 20 | 30 | 40 | 50 | 100 | 200 | Clay[i] | |
| Passing | .... | .... | .... | 100 | .... | 94 | 83 | 64 | 42 | 20 | 16 | .... | 15 | 15 | .... | .... | 10 | 2 | ... | 6.4 | W-3 |
| Retained | .... | .... | .... | 0 | .... | 6 | 11 | 19 | 22 | 22 | 4 | .... | 1 | 0 | .... | .... | 5 | 8 | 2 | ..... | |
| Passing | .... | 100 | .... | 92 | .... | 81 | 72 | 66 | 59 | 46 | 37 | .... | 31 | 29 | .... | .... | 5 | 1 | ... | 1.2 | W-4 |
| Retained | .... | 0 | .... | 8 | .... | 11 | 9 | 6 | 7 | 13 | 9 | .... | 6 | 2 | .... | .... | 24 | 4 | 1 | ..... | |
| Passing | .... | .... | .... | 100 | .... | 99 | 93 | 86 | 74 | 46 | 26 | .... | 13 | 9 | .... | .... | 3 | 1 | ... | 10.9 | W-5 |
| Retained | .... | .... | .... | 0 | .... | 1 | 6 | 7 | 12 | 28 | 20 | .... | 13 | 4 | .... | .... | 6 | 2 | 1 | ..... | |
| Passing | .... | 100 | .... | 98 | .... | 90 | 80 | 68 | 60 | 41 | 30 | .... | 25 | 22 | .... | .... | 3 | ... | ... | 1.1 | W-6 |
| Retained | .... | 0 | .... | 2 | .... | 8 | 10 | 12 | 8 | 19 | 11 | .... | 5 | 3 | .... | .... | 19 | ... | 3 | ..... | |
| Passing | .... | .... | .... | 100 | .... | 99 | 96 | 91 | 84 | 68 | 53 | .... | 39 | 33 | .... | .... | 7 | 2 | ... | 4.0 | W-7 |
| Retained | .... | .... | .... | 0 | .... | 1 | 3 | 5 | 7 | 16 | 15 | .... | 14 | 6 | .... | .... | 26 | 5 | 2 | ..... | |
| Passing | .... | 100 | .... | 97 | .... | 95 | 92 | 87 | 81 | 65 | 47 | .... | 28 | 19 | .... | .... | 4 | 1 | ... | 8.9 | W-8 |
| Retained | .... | 0 | .... | 3 | .... | 2 | 3 | 5 | 6 | 16 | 18 | .... | 19 | 9 | .... | .... | 15 | 3 | 1 | ..... | |
| Passing | .... | .... | .... | .... | .... | 100 | 97 | 96 | 95 | 92 | 85 | .... | 55 | 32 | .... | .... | 3 | 1 | ... | 5.9 | W-9 |
| Retained | .... | .... | .... | .... | .... | 0 | 3 | 1 | 1 | 3 | 7 | .... | 30 | 23 | .... | .... | 29 | 2 | 1 | ..... | |
| Passing | .... | 100 | .... | 97 | .... | 96 | 89 | 86 | 83 | 73 | 60 | .... | 42 | 18 | .... | .... | 6 | 2 | ... | 4.9 | W-10 |
| Retained | .... | 0 | .... | 3 | .... | 1 | 7 | 3 | 3 | 10 | 13 | .... | 18 | 24 | .... | .... | 12 | 4 | 2 | ..... | |
| Passing | .... | .... | .... | 100 | .... | 97 | 93 | 87 | 80 | 59 | 33 | .... | 11 | 5 | .... | .... | 1 | ... | ... | 5.1 | W-11 |
| Retained | .... | .... | .... | 0 | .... | 3 | 4 | 6 | 7 | 21 | 26 | .... | 22 | 6 | .... | .... | 4 | ... | ... | ..... | |
| Passing | 100 | 91 | .... | 91 | .... | 87 | 86 | 84 | 82 | 75 | 63 | .... | 49 | 41 | .... | .... | ..9 | 1 | ... | 7.9 | W-12 |
| Retained | 0 | 9 | .... | 0 | .... | 4 | 1 | 2 | 2 | 7 | 12 | .... | 14 | 8 | .... | .... | 32 | 8 | ... | ..... | |
| Passing | .... | 100 | .... | 91 | .... | 88 | 84 | 78 | 70 | 54 | 34 | .... | 16 | 13 | .... | .... | 1 | 1 | ... | 12.0 | W-13 |
| Retained | .... | 0 | .... | 9 | .... | 3 | 4 | 6 | 8 | 16 | 20 | .... | 18 | 3 | .... | .... | 12 | 0 | 1 | ..... | |
| Passing | .... | 100 | .... | 94 | .... | 84 | 75 | 67 | 59 | 42 | 29 | .... | 21 | 18 | .... | .... | 3 | 1 | ... | 5.5 | W-14 |
| Retained | .... | 0 | .... | 6 | .... | 10 | 9 | 8 | 8 | 17 | 13 | .... | 8 | 3 | .... | .... | 15 | 2 | 1 | ..... | |
| Passing | .... | 100 | .... | 92 | .... | 87 | 79 | 70 | 62 | 46 | 35 | .... | 26 | 20 | .... | .... | 6 | 2 | ... | 6.6 | W-16 |
| Retained | .... | 0 | .... | 8 | .... | 5 | 8 | 9 | 8 | 16 | 11 | .... | 9 | 6 | .... | .... | 14 | 4 | 2 | ..... | |
| Passing | .... | 100 | .... | 96 | .... | 91 | 83 | 75 | 68 | 56 | 47 | .... | 35 | 30 | .... | .... | 5 | 2 | ... | 6.6 | W-17 |
| Retained | .... | 0 | .... | 4 | .... | 5 | 8 | 8 | 7 | 12 | 9 | .... | 12 | 5 | .... | .... | 25 | 3 | 2 | ..... | |
| Passing | .... | 100 | .... | 87 | .... | 85 | 80 | 71 | 61 | 39 | 21 | .... | 9 | 6 | .... | .... | 1 | 1 | ... | 3.6 | W-18 |
| Retained | .... | 0 | .... | 13 | .... | 2 | 5 | 9 | 10 | 22 | 18 | .... | 12 | 3 | .... | .... | 5 | 0 | 1 | ..... | |
| Passing | .... | 100 | .... | 89 | .... | 70 | 57 | 51 | 44 | 33 | 25 | .... | 19 | 17 | .... | .... | 2 | 1 | ... | 3.4 | W-19[h] |
| Retained | .... | 0 | .... | 11 | .... | 19 | 13 | 6 | 7 | 11 | 8 | .... | 6 | 2 | .... | .... | 15 | 1 | 1 | ..... | |
| Passing | .... | .... | .... | .... | .... | 100 | 99 | 95 | 88 | 64 | 42 | .... | 21 | 13 | .... | .... | 2 | 1 | ... | 7.2 | W-20 |
| Retained | .... | .... | .... | .... | .... | 0 | 1 | 4 | 7 | 24 | 22 | .... | 21 | 8 | .... | .... | 11 | 1 | 1 | ..... | |
| Passing | .... | .... | .... | .... | .... | .... | .... | .... | .... | 99 | .... | 98 | .... | 96 | .... | 79 | 44 | 4 | 2 | .7 | W-80 |
| Retained | .... | .... | .... | .... | .... | .... | .... | .... | .... | 1 | .... | 1 | .... | 2 | .... | 17 | 35 | 40 | 2 | ..... | |

[a]Passing = total per cent passing the sieve.

Retained = per cent retained on the sieve and passing the next larger sieve.

[h]Seven rocks on 2-inch sieve not included in analysis.

[i]Includes silt.

# APPENDIX E—CLIMATOLOGICAL DATA

COMPILED BY
H. B. WILLMAN

## TABLE 1.—MEAN PRECIPITATION[1]

| Month | Ottawa[2] | Streator[2] | Dwight[3] | LaSalle[2] | Minonk[2] | Morris[2] | PawPaw[2] | Pontiac[2] | Yorkv'le[4] |
|---|---|---|---|---|---|---|---|---|---|
| Length of record (years) . . . . | 64 | 33 | 29 | 35 | 43 | 25 | 24 | 39 | 35 |
| January . . . . . | 1.91 | 1.97 | 1.99 | 1.53 | 1.69 | 1.55 | 1.48 | 2.04 | 1.80 |
| February . . . . | 1.80 | 1.56 | 1.72 | 1.40 | 1.60 | 1.16 | 1.19 | 1.69 | 1.98 |
| March . . . . . | 2.58 | 2.59 | 2.86 | 2.37 | 2.56 | 2.45 | 2.58 | 2.67 | 2.20 |
| April . . . . . . | 2.88 | 2.74 | 3.16 | 2.85 | 2.96 | 2.89 | 2.70 | 3.34 | 2.80 |
| May . . . . . . | 4.00 | 3.78 | 3.84 | 3.52 | 3.77 | 3.52 | 3.37 | 3.74 | 4.35 |
| June . . . . . . | 3.37 | 3.17 | 3.68 | 3.54 | 3.43 | 3.41 | 3.88 | 3.02 | 3.96 |
| July . . . . . . | 3.26 | 3.22 | 2.93 | 2.81 | 2.97 | 2.53 | 2.54 | 2.71 | 3.42 |
| August . . . . . | 3.42 | 3.13 | 3.32 | 3.80 | 3.37 | 3.02 | 3.02 | 2.82 | 3.37 |
| September . . . . | 3.61 | 3.45 | 3.62 | 4.22 | 3.87 | 3.68 | 4.37 | 3.60 | 3.68 |
| October . . . . . | 2.20 | 2.15 | 2.31 | 2.34 | 2.34 | 2.68 | 3.16 | 2.39 | 2.47 |
| November . . . . | 2.41 | 2.36 | 2.42 | 2.05 | 2.21 | 2.56 | 2.42 | 2.23 | 2.28 |
| December . . . . | 1.82 | 1.75 | 1.80 | 1.59 | 1.74 | 1.79 | 1.61 | 1.89 | 1.70 |
| Annual . . . . . | 33.26 | 31.87 | 33.65 | 32.02 | 32.51 | 31.24 | 32.32 | 32.14 | 34.01 |

[1]U. S. Dept. Agriculture Weather Bureau reports.
[2]Data to 1936, inclusive.
[3]Data to 1928, inclusive.
[4]Data to 1915, inclusive.

## TABLE 2.—MAXIMUM PRECIPITATION[1]

| Month | Ottawa | | Streator | | LaSalle | | Minonk | | Morris | | Paw Paw | | Pontiac | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Inches | Year | Inches | Year | Inches | Year | Inches | Year | Inches | Year | Inches | Year | Inches | Year |
| January | 5.98 | 1897 | 6.61 | 1916 | 5.00 | 1916 | 6.18 | 1916 | 5.07 | 1916 | 4.63 | 1916 | 6.35 | 1916 |
| February | 4.55 | 1867 | 3.73 | 1908 | 3.06 | 1909 | 4.95 | 1887 | 2.29 | 1926 | 2.74 | 1926 | 4.52 | 1908 |
| March | 5.28 | 1868 | 6.93 | 1898 | 4.96 | 1920 | 5.04 | 1921 | 5.69 | 1920 | 5.72 | 1920 | 6.08 | 1923 |
| April | 7.11 | 1927 | 6.61 | 1909 | 6.18 | 1927 | 7.57 | 1927 | 7.64 | 1927 | 6.61 | 1929 | 7.42 | 1927 |
| May | 13.25 | 1892 | 7.35 | 1935 | 6.69 | 1908 | 8.77 | 1908 | 7.33 | 1935 | 7.85 | 1933 | 8.72 | 1908 |
| June | 10.51 | 1902 | 10.64 | 1902 | 8.90 | 1902 | 9.86 | 1924 | 6.86 | 1924 | 7.90 | 1924 | 6.76 | 1924 |
| July | 10.49 | 1902 | 8.60 | 1915 | 10.70 | 1902 | 9.12 | 1915 | 8.49 | 1915 | 8.04 | 1915 | 7.81 | 1915 |
| August | 11.21 | 1924 | 7.13 | 1900 | 9.05 | 1924 | 8.89 | 1924 | 6.77 | 1921 | 6.59 | 1924 | 6.79 | 1915 |
| September | 14.28 | 1926 | 7.93 | 1936 | 11.68 | 1926 | 11.93 | 1926 | 9.54 | 1926 | 9.01 | 1936 | 11.81 | 1911 |
| October | 5.26 | 1912 | 5.18 | 1931 | 6.07 | 1931 | 4.44 | 1923 | 4.71 | 1923 | 6.83 | 1931 | 5.05 | 1913 |
| November | 5.29 | 1935 | 5.26 | 1935 | 4.82 | 1934 | 6.06 | 1931 | 6.36 | 1931 | 7.33 | 1934 | 4.62 | 1927 |
| December | 5.90 | 1860 | 5.89 | 1895 | 3.64 | 1909 | 6.33 | 1895 | 3.27 | 1932 | 3.89 | 1921 | 4.73 | 1932 |
| Annual | 55.71 | 1862 | 53.37 | 1902 | 49.97 | 1902 | 47.29 | 1902 | 42.38 | 1927 | 38.96 | 1921 | 47.43 | 1927 |

### LENGTH OF RECORDS

Ottawa—1856-1870, Oct. 1886-Feb. 1917, July-August 1917, 1918-Feb. 1919, Nov. 1919-1936.
Streator—Apr. 1893-June 1894, Dec. 1894-1919, 1930-1936.
LaSalle—1901-1902, Aug. 1903-1936.
Minonk—1886-1887, Oct. 1895-1936.
Morris—Dec. 1911-1936.
Paw Paw—Sept. 1912-1936.
Pontiac—1887-Sept. 1891, 1903-1936.

[1]U. S. Dept. Agriculture Weather Bureau Reports.

## Table 3.—Minimum Precipitation[1]

| Month | Ottawa | | Streator | | LaSalle | | Minonk | | Morris | | Paw Paw | | Pontiac | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Inches | Year | Inches | Year | Inches | Year | Inches | Year | Inches | Year | Inches | Year | Inches | Year |
| January | 0.27 | 1912 | 0.23 | 1919 | 0.13 | 1912 | 0.14 | 1919 | 0.28 | 1919 | 0.39 | 1919 | 0.26 | 1919 |
| February | 0.13 | 1920 | 0.10 | 1907 | 0.09 | 1907 | 0.06 | 1907 | 0.16 | 1920 | 0.19 | 1920 | 0.20 | 1921 |
| March | 0.14 | 1856 | 0.41 | 1910 | 0.19 | 1910 | 0.03 | 1910 | 0.66 | 1936 | 0.38 | 1936 | 0.20 | 1910 |
| April | 0.39 | 1887 | 0.41 | 1895 | 0.66 | 1901 | 0.61 | 1901 | 0.64 | 1915 | 0.64 | 1915 | 0.87 | 1923 |
| May | 0.44 | 1934 | 0.78 | 1934 | 0.75 | 1934 | 0.47 | 1934 | 0.54 | 1934 | 0.45 | 1934 | 0.45 | 1934 |
| June | 0.43 | 1922 | 0.96 | 1893 | 0.59 | 1922 | 0.25 | 1887 | 0.48 | 1922 | 0.41 | 1922 | 0.28 | 1887 |
| July | 0.08 | 1916 | 0.45 | 1916 | 0.20 | 1916 | 0.18 | 1916 | 0.02 | 1916 | 0.26 | 1916 | 0.13 | 1887 |
| August | 0.74 | 1897 | 0.41 | 1908 | 0.65 | 1925 | 0.65 | 1886 | 0.79 | 1925 | 0.35 | 1922 | 0.11 | 1889 |
| September | 0.11 | 1867 | 0.36 | 1930 | 1.07 | 1932 | 0.39 | 1908 | 0.81 | 1913 | 1.44 | 1932 | 0.20 | 1891 |
| October | 0.17 | 1896 | 0.05 | 1896 | 0.28 | 1904 | 0.13 | 1897 | 0.59 | 1924 | 0.78 | 1924 | 0.17 | 1904 |
| November | 0.08 | 1904 | T | 1904 | 0.03 | 1904 | T | 1904 | 0.12 | 1917 | 0.24 | 1933 | 0.06 | 1904 |
| December | 0.22 | 1930 | 0.10 | 1896 | 0.20 | 1930 | T | 1896 | 0.37 | 1930 | 0.28 | 1930 | 0.30 | 1890 |
| Annual | 23.05 | 1934 | 23.09 | 1901 | 23.10 | 1925 | 22.63 | 1914 | 22.11 | 1925 | 24.39 | 1922 | 16.15 | 1887 |

Length of records—as in table 2. [1]U. S. Dept. of Agriculture Weather Bureau reports.
T = Trace.

## Table 4.—Precipitation Data at Streator by Months[1]

| Year | January | February | March | April | May | June | July | August | September | October | November | December | Annual |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1893 | ...... | ...... | ...... | 6.17 | 3.21 | 0.96 | *1.14 | *0.58 | 3.00 | *1.02 | 2.80 | 0.97 | ...... |
| 1894 | 1.90 | 0.44 | 2.95 | 1.03 | 3.62 | 2.53 | ...... | ...... | ...... | ...... | ...... | 2.10 | ...... |
| 1895 | 1.55 | 0.30 | 1.40 | 0.41 | 0.80 | *1.18 | 6.00 | 2.60 | 1.90 | 1.00 | 4.54 | 5.89 | 27.57 |
| 1896 | 1.30 | 1.15 | 0.65 | 2.63 | 5.98 | 3.27 | 5.75 | 1.52 | 3.44 | 0.05 | 2.07 | 0.10 | 27.91 |
| 1897 | 5.65 | 1.55 | 4.08 | 1.88 | 1.13 | 6.70 | 2.71 | 1.07 | 1.10 | 0.23 | 4.20 | 1.32 | 31.62 |
| 1898 | 3.43 | 1.62 | 6.93 | 3.00 | 6.00 | 3.24 | .62 | 2.96 | 4.20 | 2.99 | 2.47 | 0.77 | 38.23 |
| 1899 | 1.28 | 1.82 | *2.00 | 0.45 | 2.50 | 1.82 | 5.22 | 1.69 | 2.73 | 2.47 | 1.23 | 1.93 | 25.14 |
| 1900 | 1.49 | 3.54 | 2.85 | 1.24 | 2.44 | 1.63 | 3.13 | 7.13 | 2.56 | 2.18 | 2.57 | 0.34 | 31.10 |
| 1901 | 1.42 | 1.40 | 3.49 | 0.75 | 1.24 | 2.85 | 3.02 | 2.56 | 2.20 | 0.63 | 1.38 | 2.15 | 23.09 |
| 1902 | 0.79 | 1.32 | 4.66 | 2.17 | 4.37 | 10.64 | 8.59 | 7.11 | 5.26 | 3.24 | 3.48 | 1.74 | 53.37 |
| 1903 | 0.90 | 2.52 | 3.79 | 4.81 | 2.48 | 2.07 | 2.43 | 4.04 | 7.60 | 1.02 | 0.78 | 1.78 | 34.22 |
| 1904 | 2.23 | 1.55 | 5.76 | 3.91 | 4.46 | 2.11 | 4.60 | 2.39 | 4.15 | 0.20 | T. | 1.57 | 32.93 |
| 1905 | 1.07 | 1.38 | 2.20 | 4.22 | 4.77 | 3.01 | 4.10 | 2.15 | 2.39 | 2.64 | 1.73 | 1.41 | 31.07 |
| 1906 | 2.26 | 1.99 | 2.77 | 1.40 | 1.79 | 3.10 | 1.39 | 2.25 | 4.25 | 1.64 | 2.75 | 3.06 | 28.65 |
| 1907 | 5.64 | 0.10 | 3.02 | 2.92 | 3.70 | 3.95 | 7.61 | 5.08 | 5.58 | 0.51 | 2.06 | 1.41 | 41.58 |
| 1908 | 0.59 | 3.73 | 2.53 | 4.15 | 7.16 | 1.69 | 3.62 | 0.41 | 0.39 | 0.68 | 2.36 | 0.92 | 28.23 |
| 1909 | 1.37 | 3.45 | 1.81 | 6.61 | 2.76 | 4.79 | 2.60 | 3.31 | 2.74 | 2.21 | 3.73 | 2.85 | 38.23 |
| 1910 | 2.45 | 1.03 | 0.41 | 4.20 | 5.13 | 2.98 | 0.81 | 5.38 | 4.59 | 1.43 | 0.43 | 1.81 | 30.65 |
| 1911 | 2.22 | 1.91 | 1.77 | 3.50 | 2.33 | 4.24 | 2.44 | 4.20 | 6.77 | *3.26 | 2.86 | 2.17 | 37.67 |
| 1912 | 0.44 | 1.24 | 1.89 | 4.62 | 4.73 | 1.15 | 3.08 | 1.88 | 3.18 | 3.61 | 2.55 | 0.78 | 29.15 |
| 1913 | 1.76 | 2.58 | 3.64 | 2.91 | 5.57 | 1.87 | 1.59 | 3.28 | 1.21 | 2.29 | 2.30 | 1.89 | 30.89 |
| 1914 | 1.77 | 0.91 | 1.84 | 1.75 | 3.34 | 2.17 | 0.56 | 3.05 | 4.36 | 2.38 | 0.28 | 2.01 | 24.42 |
| 1915 | 1.51 | 2.00 | 0.84 | 0.99 | 5.66 | 1.85 | 8.60 | 4.42 | 6.23 | 0.99 | 2.08 | 1.43 | 36.60 |
| 1916 | 6.61 | 0.42 | 1.84 | 1.28 | 5.04 | 7.01 | 0.45 | 3.01 | 2.77 | 4.42 | 2.67 | 2.68 | 38.20 |
| 1917 | 1.85 | 0.31 | 2.26 | 3.66 | 2.50 | 4.50 | 3.34 | 2.43 | 3.43 | 3.08 | 0.06 | 1.05 | 28.47 |
| 1918 | 2.25 | 1.70 | 0.75 | 3.33 | 4.09 | 4.53 | 2.98 | 3.16 | 1.62 | 2.93 | 2.43 | 2.31 | 32.08 |
| 1919 | 0.23 | 2.30 | 3.96 | 2.87 | 4.18 | 2.95 | 2.93 | 1.74 | 3.27 | *3.35 | *3.27 | *0.51 | 31.56 |
| 1930 | *2.32 | *1.71 | *1.81 | 4.85 | 2.60 | 3.38 | 0.73 | 1.83 | 0.36 | 2.32 | 2.82 | 0.27 | 25.00 |
| 1931 | 0.70 | 0.75 | 2.63 | 2.57 | 5.05 | 3.58 | 2.78 | 2.74 | 3.45 | 5.18 | 5.22 | 2.17 | 36.82 |
| 1932 | 1.59 | 1.04 | 2.55 | 1.33 | 4.26 | 3.17 | 3.98 | 6.14 | 1.83 | 3.49 | 0.68 | 2.73 | 32.79 |
| 1933 | 2.03 | 1.41 | 2.92 | 3.65 | 4.71 | 1.32 | 1.51 | 2.30 | 5.11 | 3.85 | 0.48 | 0.99 | 30.28 |
| 1934 | 0.74 | 0.62 | 1.27 | 0.64 | 0.78 | 1.86 | 3.26 | 3.73 | 3.59 | 1.21 | 4.13 | 1.40 | 23.23 |
| 1935 | 2.33 | 2.25 | 3.32 | 2.21 | 7.35 | 4.65 | 3.50 | 3.24 | 3.71 | 0.90 | 5.26 | 1.20 | 39.92 |
| 1936 | 1.64 | 1.25 | 1.05 | 1.13 | 2.77 | 1.23 | 1.47 | 3.78 | 7.93 | 3.77 | 2.01 | 3.57 | 31.60 |
| Mean | 1.97 | 1.56 | 2.59 | 2.74 | 3.78 | 3.17 | 3.22 | 3.13 | 3.45 | 2.15 | 2.36 | 1.75 | 31.87 |

[1]U. S. Dept. Agriculture Weather Bureau reports. *Estimated from surrounding stations.

TABLE 5.—PRECIPITATION DATA AT OTTAWA BY MONTHS[1]

| Year | January | February | March | April | May | June | July | August | September | October | November | December | Annual |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1856 | 1.90 | 0.43 | 0.14 | 1.36 | 6.20 | 2.11 | 2.71 | 1.54 | 2.38 | 2.86 | 3.64 | 4.82 | 30.09 |
| 1857 | 0.46 | 4.45 | 3.06 | 1.41 | 3.65 | 3.95 | 3.97 | 6.10 | 0.89 | 2.68 | 2.96 | 1.12 | 34.70 |
| 1858 | 1.65 | 3.15 | 2.98 | 4.55 | 8.36 | 6.57 | 4.82 | 2.37 | 3.55 | 3.97 | 2.35 | 2.55 | 46.87 |
| 1859 | 1.71 | 0.86 | 5.24 | 4.08 | 3.12 | 1.68 | 0.73 | 3.44 | 1.66 | 2.34 | 2.09 | 0.94 | 27.89 |
| 1860 | 2.66 | 1.59 | 0.70 | 1.49 | 2.20 | 2.54 | 2.89 | 0.79 | 1.88 | 0.40 | 4.03 | 5.90 | 27.07 |
| 1861 | 1.22 | 1.95 | 2.54 | 4.97 | 3.60 | 4.64 | 5.23 | 2.41 | 5.17 | 3.57 | 1.44 | 2.15 | 38.89 |
| 1862 | 5.80 | 1.29 | 4.16 | 4.85 | 3.61 | 5.61 | 8.92 | 6.82 | 7.55 | 2.49 | 2.48 | 2.13 | 55.71 |
| 1863 | *2.92 | 3.29 | 3.26 | 3.26 | 3.64 | *0.84 | *2.48 | 3.11 | 2.74 | 4.23 | 1.78 | 1.40 | 32.95 |
| 1864 | 2.43 | 1.64 | 2.70 | 3.64 | 1.79 | 1.52 | 2.94 | 1.85 | 2.58 | 1.66 | 3.29 | 3.49 | 29.53 |
| 1865 | 0.45 | 3.99 | 3.15 | 5.48 | *1.78 | 5.17 | 5.01 | 5.50 | 3.89 | 1.84 | 0.49 | 0.59 | 37.34 |
| 1866 | 2.85 | 2.49 | 1.97 | 1.62 | 2.16 | 1.57 | 5.73 | 3.62 | 4.72 | 2.16 | 0.90 | 2.97 | 32.76 |
| 1867 | 1.28 | 4.55 | 1.42 | 1.72 | 4.64 | 3.73 | 4.23 | 2.41 | 0.11 | 0.92 | *1.81 | 1.66 | 28.48 |
| 1868 | 1.07 | 1.40 | 5.28 | 2.60 | 7.64 | 2.21 | 1.96 | 3.19 | 3.48 | *1.18 | *3.64 | *1.30 | 34.95 |
| 1869 | *1.46 | 1.95 | 1.38 | 4.58 | 7.45 | 6.27 | 4.40 | 4.24 | *2.06 | 1.48 | 1.88 | 1.63 | 38.78 |
| 1870 | 5.28 | 0.90 | 3.68 | 0.85 | 1.15 | 1.39 | 1.90 | 2.26 | 3.63 | 4.33 | 1.42 | *1.31 | 28.10 |
| 1886 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | 1.60 | 0.60 | 0.43 | ...... |
| 1887 | 1.82 | 3.25 | 0.64 | 0.39 | 1.08 | 1.12 | 1.17 | 3.06 | 2.77 | 2.80 | 2.17 | 3.33 | 23.60 |
| 1888 | 1.80 | 1.88 | 3.70 | 1.23 | 5.39 | 2.01 | 3.58 | 1.77 | 0.60 | 2.71 | 3.38 | 2.22 | 30.27 |
| 1889 | 1.91 | 1.16 | 1.77 | 2.44 | 4.36 | 4.61 | 5.67 | 2.00 | 3.92 | 1.51 | 3.12 | 1.80 | 34.27 |
| 1890 | 1.94 | 1.40 | 3.33 | 1.87 | 3.99 | 6.87 | 0.34 | 2.72 | 2.48 | 3.89 | 2.06 | 0.27 | 31.16 |
| 1891 | 2.86 | 2.28 | 2.56 | 3.96 | 1.84 | 3.99 | 4.45 | 5.11 | 1.27 | 0.56 | 4.75 | 1.74 | 35.37 |
| 1892 | 1.45 | 1.52 | 2.70 | 3.56 | 13.25 | 9.80 | 4.92 | 0.81 | 2.56 | 0.63 | 2.48 | 1.84 | 45.52 |
| 1893 | 2.20 | 3.03 | 3.30 | 5.23 | 1.95 | 2.49 | 1.02 | 0.77 | 2.29 | 1.10 | 2.18 | 2.16 | 27.72 |
| 1894 | 2.38 | 1.58 | 2.57 | 1.51 | 4.01 | 3.03 | 0.80 | 1.75 | 7.18 | 1.63 | 2.09 | 1.19 | 29.72 |
| 1895 | 1.22 | 0.70 | 0.82 | 2.02 | 1.06 | 1.02 | 4.79 | 2.26 | 1.47 | 1.16 | 5.27 | 5.77 | 27.56 |
| 1896 | 1.37 | 1.65 | 1.32 | 3.38 | 4.24 | 2.22 | 8.63 | 2.43 | 9.38 | 0.17 | 3.43 | 0.28 | 38.50 |
| 1897 | 5.98 | 1.71 | 4.47 | 1.88 | 0.99 | 6.90 | 2.99 | 0.74 | 1.89 | 0.46 | 4.37 | 1.74 | 34.12 |
| 1898 | 5.24 | 2.38 | 5.21 | 3.12 | 6.72 | 5.80 | 1.30 | 4.31 | 5.90 | 4.73 | 2.88 | 1.42 | 49.01 |
| 1899 | 0.63 | 2.10 | 3.21 | 1.50 | 5.08 | 1.42 | 5.70 | 3.02 | 2.15 | 2.53 | 1.46 | 2.03 | 30.83 |
| 1900 | 1.60 | 4.53 | 2.91 | 1.53 | 5.60 | 1.96 | 4.53 | 7.24 | 2.26 | 2.24 | 3.16 | 0.31 | 37.87 |
| 1901 | 1.76 | 2.10 | 3.51 | 0.61 | 2.15 | 2.67 | 5.47 | 0.81 | 3.20 | 0.91 | 1.49 | 2.09 | 26.77 |
| 1902 | 0.63 | 1.41 | 4.89 | 2.55 | 5.64 | 10.51 | 10.49 | 4.40 | 6.76 | 1.87 | 4.29 | 2.01 | 55.45 |
| 1903 | 1.13 | 2.35 | 3.10 | 5.08 | 4.19 | 3.78 | 1.94 | 4.90 | 6.03 | 1.43 | 0.46 | 1.91 | 36.30 |
| 1904 | 2.54 | 1.80 | 4.87 | 3.93 | 3.00 | 1.89 | 5.14 | 3.58 | 3.27 | 0.26 | 0.08 | 1.86 | 32.22 |
| 1905 | 1.30 | 1.93 | 2.09 | 5.15 | 3.68 | 3.39 | 1.68 | 4.12 | 2.13 | 1.87 | 2.01 | 1.70 | 31.05 |
| 1906 | 2.07 | 2.26 | 2.02 | 1.63 | 2.37 | 2.64 | 1.45 | 4.57 | 5.09 | 1.23 | 2.63 | 1.22 | 29.18 |
| 1907 | 5.25 | 0.15 | 2.55 | 2.69 | 4.84 | 2.50 | 6.92 | 4.49 | 4.94 | 1.00 | 1.96 | 1.79 | 39.08 |
| 1908 | 0.86 | 1.53 | 3.87 | 3.48 | 8.17 | 1.77 | 3.05 | 2.03 | 0.35 | 0.65 | 1.79 | 0.99 | 28.54 |
| 1909 | 0.98 | 3.65 | 1.64 | 5.19 | 2.57 | 3.69 | 2.95 | 3.59 | 4.08 | 1.71 | 2.57 | 3.02 | 35.64 |
| 1910 | 2.78 | 0.98 | 0.42 | 3.28 | 5.28 | 1.25 | 0.67 | 3.91 | 6.23 | 1.25 | 0.74 | 0.98 | 27.77 |
| 1911 | 1.80 | 2.13 | 1.80 | 3.91 | 2.64 | 1.71 | 1.60 | 6.28 | 6.88 | 2.61 | 2.28 | 2.15 | 35.79 |
| 1912 | 0.27 | 1.14 | 1.17 | 3.30 | 6.13 | 2.09 | 3.28 | 5.68 | 2.86 | 5.26 | 2.02 | 1.18 | 34.38 |
| 1913 | 1.80 | 3.00 | 3.87 | 2.09 | 6.71 | 2.36 | 2.17 | 2.98 | 2.10 | 2.70 | 1.80 | 0.59 | 32.17 |
| 1914 | 1.77 | 1.10 | 2.35 | 1.28 | 4.06 | 2.53 | 0.66 | 2.33 | 2.87 | 3.17 | 0.40 | 1.92 | 24.44 |
| 1915 | 1.86 | 2.13 | 1.01 | 0.75 | 5.63 | 2.10 | 7.30 | 2.80 | 4.88 | 0.86 | 1.95 | 0.82 | 32.09 |
| 1916 | *5.11 | 0.59 | 1.92 | 0.86 | 3.90 | 7.39 | 0.08 | 1.05 | 1.54 | 4.75 | 2.48 | 1.34 | 31.01 |
| 1917 | *1.11 | 0.34 | ...... | ...... | ...... | ...... | 1.70 | 3.03 | ...... | ...... | ...... | ...... | ...... |
| 1918 | *1.95 | *1.75 | *0.57 | 2.36 | 4.58 | 1.87 | 1.71 | 4.27 | 2.27 | 3.18 | 2.33 | *2.39 | 29.23 |
| 1919 | 0.42 | 2.02 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | 2.94 | 0.62 | ...... |
| 1920 | 1.61 | 0.13 | 4.77 | 5.79 | 3.53 | 1.92 | 0.89 | 1.05 | *2.20 | *2.03 | 1.19 | 2.12 | 27.23 |
| 1921 | 0.71 | 0.32 | 3.98 | 4.27 | 2.15 | 2.87 | 1.11 | 6.38 | 6.87 | *2.53 | *2.86 | *3.11 | 37.16 |
| 1922 | *1.25 | 0.92 | 2.91 | 2.57 | 6.39 | 0.43 | 3.21 | 1.63 | 3.37 | 2.08 | 2.01 | 1.32 | 28.09 |
| 1923 | *0.88 | 1.30 | *3.13 | 1.03 | 4.40 | 2.47 | 1.36 | 3.26 | 3.22 | 3.72 | 1.64 | *2.17 | 28.58 |
| 1924 | 1.32 | 1.59 | 2.07 | 1.54 | 2.36 | 6.40 | 4.40 | 11.21 | 4.35 | 0.56 | 0.60 | 1.98 | 38.38 |
| 1925 | 0.36 | 1.71 | 0.80 | 2.72 | 1.46 | 3.34 | 1.95 | 1.08 | 2.88 | 2.95 | 3.00 | 0.99 | 23.24 |
| 1926 | 0.99 | 2.60 | 2.60 | 3.16 | 3.41 | 4.11 | 8.20 | 2.68 | 14.28 | 1.38 | 4.54 | 0.61 | 48.56 |
| 1927 | 0.95 | 2.24 | 2.28 | 7.11 | 4.49 | 5.01 | 1.07 | 6.57 | 3.56 | 3.40 | 4.65 | 1.99 | 42.32 |
| 1928 | 0.38 | 1.50 | 0.99 | 2.23 | 2.33 | 5.10 | 3.56 | 3.65 | 1.45 | 3.01 | 4.36 | 2.11 | 30.67 |
| 1929 | 3.39 | 0.54 | 2.98 | 6.57 | 2.16 | 4.18 | 2.78 | 2.58 | 2.39 | 2.86 | 1.36 | 0.63 | 32.42 |
| 1930 | 2.01 | 2.11 | 1.40 | 4.42 | 1.30 | 2.57 | 0.90 | 0.94 | 2.45 | 2.95 | 2.32 | 0.22 | 23.59 |
| 1931 | 0.70 | 0.88 | 2.49 | 2.19 | 4.03 | 5.18 | 1.24 | 3.60 | 4.14 | 4.64 | 4.07 | 2.39 | 35.52 |

Table 5.—*Con't.*

| Year | January | February | March | April | May | June | July | August | September | October | November | December | Annual |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1932 | 2.41 | 1.14 | 2.34 | 1.16 | 3.14 | 2.29 | 3.58 | 6.34 | 1.83 | 3.89 | 0.60 | 3.16 | 31.88 |
| 1933 | 1.84 | 1.14 | 3.01 | 3.42 | 5.02 | 1.40 | 1.80 | 2.30 | 2.84 | 1.83 | 0.64 | 0.92 | 26.16 |
| 1934 | 0.78 | 0.50 | 0.85 | 1.02 | 0.44 | 2.87 | 2.53 | 2.02 | 4.81 | 1.37 | 4.77 | 1.09 | 23.05 |
| 1935 | 2.26 | 2.00 | 2.75 | 1.87 | 6.43 | 5.53 | 3.21 | 6.91 | 3.26 | 0.98 | 5.29 | 1.16 | 41.65 |
| 1936 | 1.19 | 1.14 | 1.06 | 1.71 | 2.35 | 0.70 | 1.07 | 3.80 | 9.16 | 2.11 | 0.90 | 3.65 | 28.84 |
| Mean | 1.91 | 1.80 | 2.58 | 2.88 | 4.00 | 3.37 | 3.26 | 3.42 | 3.61 | 2.20 | 2.41 | 1.82 | 33.26 |

[1]U. S. Dept. Agriculture Weather Bureau reports.
*Estimated from surrounding stations.

Table 6.—Snowfall Data[1]

| | Ottawa[2] | Paw Paw[3] | Minonk[2] | Pontiac[2] |
|---|---|---|---|---|
| Length of record (years): | 43 | 18 | 40 | 34 |
| Months | Av. in inches | Av. in inches | Av. in inches | Av. in inches |
| January | 6.9 | 7.8 | 5.8 | 8.1 |
| February | 6.5 | 4.4 | 5.9 | 6.1 |
| March | 4.3 | 4.4 | 4.4 | 4.8 |
| April | 1.3 | 1.2 | 1.5 | 1.4 |
| May | T. | T. | T. | T. |
| June | 0.0 | 0.0 | 0.0 | 0.0 |
| July | 0.0 | 0.0 | 0.0 | 0.0 |
| August | 0.0 | 0.0 | 0.0 | 0.0 |
| September | 0.0 | 0.0 | 0.0 | 0.0 |
| October | T. | 0.7 | 0.1 | 0.3 |
| November | 1.6 | 1.5 | 1.9 | 1.3 |
| December | 4.0 | 4.8 | 5.2 | 6.7 |
| Annual | 24.6 | 24.8 | 24.8 | 28.7 |

[1]U. S. Dept. of Agriculture Weather Bureau reports.
[2]Data to 1936, inclusive.
[3]Data to 1930, inclusive.

TABLE 7.—TEMPERATURE DATA[1]

(Degrees Fahrenheit)

| | Absolute Maximum[2] | | | Average of daily Maxima[3] | | | Mean[2] | | | Average of daily Minima[3] | | | Absolute Minimum[2] | | | Range of average daily extremes | | | Range of absolute extremes | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Ottawa | Minonk | Pontiac | Ottawa | Minonk | Pontiac | Ottawa | Minonk | Pontiac | Ottawa | Minonk | Pontiac | Ottawa | Minonk | Pontiac | Ottawa | Minonk | Pontiac | Ottawa | Minonk | Pontiac |
| Length of record (years) . . . . | 44 | 40 | 34 | 30 | 29 | 28 | 48 | 42 | 38 | 30 | 30 | 28 | 44 | 40 | 34 | 30 | 30 | 28 | 44 | 40 | 34 |
| January . . . . | 68 | 69 | 69 | 33.4 | 32.8 | 33.5 | 24.7 | 24.5 | 26.2 | 16.0 | 15.0 | 16.8 | −26 | −23 | −24 | 17.4 | 17.8 | 16.7 | 94 | 92 | 93 |
| February . . . . | 73 | 71 | 72 | 35.8 | 35.7 | 37.2 | 26.6 | 26.3 | 28.3 | 17.5 | 17.5 | 20.2 | −24 | −28 | −23 | 18.3 | 18.2 | 17.0 | 97 | 99 | 95 |
| March . . . . . | 85 | 88 | 86 | 49.0 | 49.7 | 50.4 | 37.7 | 38.3 | 39.4 | 28.6 | 29.0 | 30.7 | −6 | −7 | −5 | 20.4 | 20.7 | 19.7 | 91 | 95 | 91 |
| April . . . . . | 93 | 93 | 92 | 62.6 | 61.8 | 62.5 | 50.6 | 50.1 | 51.2 | 38.6 | 38.1 | 40.0 | 12 | 8 | 15 | 24.0 | 23.7 | 22.5 | 81 | 85 | 77 |
| May . . . . . . | 106 | 103 | 102 | 74.3 | 73.8 | 74.1 | 59.4 | 61.8 | 62.1 | 49.0 | 48.8 | 50.3 | 22 | 26 | 29 | 25.3 | 25.0 | 23.8 | 84 | 77 | 73 |
| June . . . . . . | 107 | 105 | 105 | 82.4 | 82.3 | 83.1 | 70.9 | 70.4 | 71.6 | 57.9 | 57.5 | 59.2 | 35 | 36 | 38 | 24.5 | 24.8 | 23.9 | 72 | 69 | 67 |
| July . . . . . . | 112 | 111 | 108 | 88.1 | 88.0 | 88.5 | 75.7 | 75.8 | 76.8 | 62.7 | 62.2 | 64.0 | 42 | 42 | 45 | 25.4 | 25.8 | 24.5 | 70 | 69 | 63 |
| August . . . . | 107 | 105 | 104 | 85.6 | 86.0 | 86.2 | 72.6 | 73.4 | 74.2 | 60.3 | 60.5 | 62.2 | 33 | 39 | 40 | 25.3 | 25.5 | 24.0 | 74 | 66 | 64 |
| September . . . | 102 | 104 | 103 | 78.2 | 78.6 | 79.3 | 65.6 | 66.5 | 67.3 | 53.8 | 53.9 | 55.8 | 25 | 22 | 30 | 24.4 | 24.7 | 23.5 | 77 | 82 | 73 |
| October . . . | 91 | 92 | 94 | 66.4 | 66.3 | 66.4 | 53.5 | 54.3 | 54.7 | 42.5 | 42.3 | 43.9 | 13 | 10 | 9 | 23.9 | 24.0 | 22.5 | 78 | 82 | 85 |
| November . . . | 82 | 82 | 82 | 50.9 | 50.7 | 51.2 | 40.0 | 40.4 | 41.7 | 31.2 | 30.7 | 32.7 | −6 | −9 | −5 | 19.7 | 20.0 | 18.5 | 88 | 91 | 87 |
| December . . . | 69 | 67 | 67 | 36.1 | 36.1 | 37.0 | 28.7 | 27.8 | 29.9 | 20.0 | 19.5 | 21.6 | −23 | −24 | −23 | 16.1 | 16.6 | 15.4 | 92 | 91 | 90 |
| Annual . . . . | 112 | 111 | 108 | 61.9 | 61.8 | 62.4 | 50.6 | 50.8 | 51.9 | 39.8 | 39.6 | 41.4 | −26 | −28 | −24 | 22.1 | 22.2 | 21.0 | 83 | 83 | 80 |

[1]Compiled from U. S. Dept. Agriculture Weather Bureau reports.

[2]Data to 1936, inclusive.

[3]Data to 1930, inclusive.

Table 8.—Frost Data at Ottawa[1]

| Year | Date of last killing frost in spring | Date of first killing frost in autumn | Length of growing season—(days) |
|---|---|---|---|
| 1893 | May 6 | Sept. 26 | 143 |
| 1894 | Apr. 13 | Oct. 6 | 176 |
| 1895 | May 21 | Sept. 30 | 132 |
| 1896 | Apr. 10 | Sept. 20 | 163 |
| 1897 | May 1 | Oct. 25 | 177 |
| 1898 | Apr. 7 | Oct. 14 | 190 |
| 1899 | Apr. 19 | Sept. 27 | 161 |
| 1900 | Apr. 14 | Oct. 17 | 186 |
| 1901 | Apr. 20 | Sept. 19 | 152 |
| 1902 | Apr. 24 | Oct. 14 | 173 |
| 1903 | May 1 | Oct. 18 | 170 |
| 1904 | Apr. 21 | Oct. 22 | 185 |
| 1905 | Apr. 22 | Oct. 21 | 182 |
| 1906 | Apr. 23 | Oct. 10 | 170 |
| 1907 | May 11 | Oct. 13 | 155 |
| 1908 | May 2 | Oct. 2 | 153 |
| 1909 | May 3 | Oct. 12 | 162 |
| 1910 | May 5 | Oct. 28 | 176 |
| 1911 | May 3 | Oct. 24 | 174 |
| 1912 | Apr. 19 | Oct. 23 | 187 |
| 1913 | May 11 | Oct. 21 | 163 |
| 1914 | Apr. 20 | Oct. 26 | 189 |
| 1915 | Apr. 3 | Oct. 9 | 179 |
| 1916 | Apr. 10 | Oct. 11 | 184 |
| 1917 | May 10 | .... | ... |
| 1918 | May 1 | Nov. 2 | 185 |
| 1919 | Apr. 25 | .... | ... |
| 1920 | May 14 | Oct. 29 | 168 |
| 1921 | May 16 | .... | ... |
| 1922 | Apr. 29 | Oct. 13 | 167 |
| 1923 | May 10 | Sept. 14 | 127 |
| 1924 | Apr. 18 | Oct. 23 | 188 |
| 1925 | May 26 | Oct. 10 | 137 |
| 1926 | May 4 | Sept. 26 | 145 |
| 1927 | Apr. 24 | Oct. 10 | 169 |
| 1928 | May 13 | Sept. 24 | 134 |
| 1929 | May 21 | Oct. 4 | 136 |
| 1930 | Apr. 26 | Oct. 1 | 158 |
| 1931 | May 23 | Oct. 18 | 149 |
| 1932 | May 2 | Oct. 11 | 163 |
| 1933 | Apr. 27 | Oct. 13 | 170 |
| 1934 | May 26 | Oct. 28 | 155 |
| 1935 | May 4 | Oct. 4 | 154 |
| 1936 | Apr. 23 | Oct. 2 | 163 |
| Average | Apr. 30 | Oct. 11 | 164 |
| Earliest date of last killing frost in spring | Apr. 3 | | |
| Latest date of killing frost in spring | May 26 | | |
| Earliest date of killing frost in autumn | | Sept. 14 | |
| Latest date of first killing frost in autumn | | Nov. 2 | |
| Longest growing season | | | 190 |
| Shortest growing season | | | 127 |

[1]U. S. Dept. Agriculture Weather Bureau reports.

TABLE 9.—MISCELLANEOUS CLIMATOLOGICAL DATA[1]

| Months | Greatest Precipitation in 24 hours in State | Average Greatest Precipitation in 24 hours in State | Average Number of Days | | | | Prevailing wind direction, at Ottawa | Mean Relative Humidity at Peoria | | | Percentage of possible sunshine, at Peoria |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Precipitation 0.01 inch or more, at Ottawa | Clear, in State | Partly cloudy, in State | Cloudy, in State | | 8:00 A.M. | Noon | 8:00 P.M. | |
| Lgth. of Record (Yrs.) | 38 | 38 | 37 | 42 | 42 | 42 | 20 | 26 | 13 | 26 | 26 |
| January | 4.12 | 2.36 | 8 | 11 | 7 | 13 | NW | 89 | 74 | 81 | 49 |
| February | 4.03 | 2.05 | 7 | 11 | 7 | 10 | NW | 88 | 71 | 78 | 55 |
| March | 7.16 | 3.08 | 9 | 11 | 8 | 12 | NW | 85 | 62 | 69 | 59 |
| April | 6.21 | 2.65 | 10 | 12 | 8 | 10 | SW | 79 | 58 | 62 | 60 |
| May | 5.52 | 3.53 | 11 | 13 | 9 | 9 | SW | 77 | 54 | 54 | 66 |
| June | 10.25 | 4.43 | 10 | 14 | 10 | 6 | SW | 80 | 56 | 60 | 72 |
| July | 6.60 | 4.54 | 8 | 17 | 10 | 4 | SW | 80 | 53 | 58 | 77 |
| August | 9.15 | 4.46 | 8 | 16 | 10 | 5 | SW | 84 | 56 | 66 | 71 |
| September | 8.06 | 4.14 | 9 | 15 | 8 | 7 | SW | 88 | 55 | 71 | 65 |
| October | 7.99 | 3.02 | 7 | 16 | 7 | 8 | SW | 88 | 58 | 71 | 61 |
| November | 4.50 | 2.37 | 8 | 12 | 7 | 11 | SW | 87 | 68 | 74 | 52 |
| December | 5.15 | 2.38 | 8 | 11 | 6 | 14 | SW | 90 | 75 | 82 | 46 |
| Annual | 10.25 | . . . | 103 | 160 | 95 | 110 | . . | 84 | 62 | 69 | 61 |

[1]U. S. Dept. Agriculture Weather Bureau reports to 1930, inclusive.

# APPENDIX F

# STREAM-FLOW DATA[a]

Compiled by

H. B. Willman

## Stream-Flow Data

| River | Illinois[b] | Fox |
|---|---|---|
| Location of gaging station | Morris | Wedron |
| Records available | | |
| Dates | Oct., 1919—Sept., 1935 | Nov., 1914—Sept., 1924 |
| Interval | 16 years | 9 years, 11 months |
| Drainage area | [c] | 2,500 sq. miles |

| Discharge data | Illinois Sec.-ft.[d] | Illinois Date | Fox Sec.-ft. | Fox Date |
|---|---|---|---|---|
| Aver. mean daily discharge | 13,380 | | 1,537 | |
| Mac. mean daily discharge | 62,300 | Apr. 2, 1933 | 17,900 | Mar. 26, 1920 |
| Min. mean daily discharge | 5,120 | Aug. 21, 1929 | 145 | Sept. 4, 1918 |
| Max. mean yearly[e] discharge | 17,300 | 1926-27 | 2,080 | 1915-16 |
| Min. mean yearly discharge | 9,740 | 1930-31 | 840 | 1922-23 |
| Aver. yearly run-off in inches[f] | | | 8.35 | |
| Max. yearly run-off in inches | | | 11.33 | 1916 |
| Min. yearly run-off in inches | | | 4.56 | 1923 |

| Mean daily discharge by months (sec.-ft.) | Illinois Aver. | Illinois Maximum | Illinois Minimum | Fox Aver. | Fox Maximum | Fox Minimum |
|---|---|---|---|---|---|---|
| January | 12,870 | 18,300 ('28) | 8,970 ('31) | 1,178 | 3,510 ('16) | 365 ('18) |
| February | 13,880 | 23,600 ('27) | 8,580 ('31) | 1,648 | 3,860 ('18) | 420 ('23) |
| March | 16,890 | 24,200 ('29) | 8,390 ('31) | 3,715 | 6,140 ('20) | 781 ('16) |
| April | 19,160 | 33,200 ('22) | 10,600 ('31) | 2,924 | 4,580 ('20) | 639 ('16) |
| May | 15,290 | 28,300 ('33) | 9,990 ('34) | 1,813 | 3,860 ('19) | 670 ('23) |
| June | 12,780 | 18,700 ('24) | 9,350 ('21) | 1,457 | 3,600 ('16) | 396 ('23) |
| July | 11,020 | 17,700 ('28) | 8,660 ('30) | 776 | 1,730 ('24) | 130 ('16) |
| August | 10,720 | 19,200 ('24) | 8,830 ('20) | 998 | 4,910 ('24) | 4.98 ('16) |
| September | 10,871 | 19,100 ('26) | 8,730 ('35) | 738 | 1,840 ('24) | 1.66 ('16) |
| October | 11,520 | 21,100 ('26) | 7,820 ('30) | 1,038 | 1,610 ('21) | 401 ('20) |
| November | 12,310 | 18,900 ('26) | 7,540 ('30) | 1,112 | 2,100 ('21) | 106 ('15) |
| December | 13,370 | 25,200 ('27) | 8,380 ('30) | 1,158 | 3,480 ('21) | 107 ('15) |

[a]Data compiled from reports of U. S. Geological Survey, Surface Water Supply of the United States, Part 5, Hudson Bay and Upper Mississippi River Basins, Water-Supply Papers 405, 435, 455, 475, 505, 525, 545, 565, 585, 605, 625, 645, 665, 685, 700, 715, 730, 745, 760, 785.

[b]Includes flow diverted from Lake Michigan by Chicago Sanitary and Ship Canal.

[c]Indeterminate.

[d]"Second-feet" is the abbreviation for "cubic feet per second." One second-foot is the rate of discharge of water flowing in a channel when the cross-sectional area is 1 square foot and the average velocity is 1 foot per second.

[e]All yearly data are based on the water-year, which extends from October 1 to September 30.

[f]Run-off in inches is the depth to which an area would be covered if all the water flowing from it in a given period were uniformly distributed on the surface.

| Fox<br>Dayton<br><br>May, 1925—Sept., 1935<br>10 years, 5 months<br>2,570 sq. miles | | Vermilion<br>Streator<br><br>Aug., 1914—Sept., 1930<br>16 years, 2 months<br>1,080 sq. miles | | Vermilion<br>Lowell<br><br>May, 1931—Sept., 1935<br>4 years, 5 months<br>1,230 sq. miles | |
|---|---|---|---|---|---|
| Sec.-ft. | Date | Sec.-ft. | Date | Sec.-ft. | Date |
| 1,414 | | 660 | | 741 | |
| 14,300 | April 1, 1929 | 16,500 | April 20, 1920 | 19,700 | May 12, 1933 |
| 145 | 16 days in July Aug., Sept., 1934 | No flow | Aug., Sept., 1920, 1923 | 5.9 | Aug. 2, 4, 1934 |
| 2,590 | 1928-29 | 1,930 | 1926-27 | 1,073 | 1934-35 |
| 330 | 1933-34 | 277 | 1924-25 | 169 | 1933-34 |
| 7.48 | | 7.91 | | 8.15 | |
| 13.70 | 1929 | 24.34 | 1927 | 11.85 | 1935 |
| 1.87 | 1934 | 2.20 | 1923 | 1.75 | 1934 |

| Average | Maximum | Minimum | Average | Maximum | Minimum | Average | Maximum | Minimum |
|---|---|---|---|---|---|---|---|---|
| 1,188 | 2,530 ('32) | 462 ('34) | 542 | 2,740 ('16) | 2 ('18) | 1,025 | 1,730 ('32) | 135 ('34) |
| 1,616 | 3,570 ('27) | 338 ('34) | 934 | 3,510 ('27) | 41.8 ('23) | 920 | 1,428 ('35) | 111 ('34) |
| 2,535 | 6,700 ('29) | 412 ('34) | 1,245 | 2,550 ('29) | 71.1 ('15) | 1,319 | 2,688 ('35) | 169 ('34) |
| 2,896 | 6,200 ('29) | 418 ('34) | 1,478 | 4,000 ('27) | 45.2 ('15) | 1,327 | 3,040 ('33) | 470 ('34) |
| 1,957 | 5,500 ('33) | 217 ('34) | 978 | 3,900 ('27) | 103 ('25) | 1,818 | 4,260 ('33) | 93.4 ('34) |
| 1,339 | 2,390 ('27) | 267 ('34) | 624 | 1,950 ('17) | 59.3 ('25) | 460 | 938 ('35) | 27.7 ('34) |
| 903 | 2,630 ('28) | 174 ('34) | 239 | 551 ('29) | 11.7 ('19) | 259 | 726 ('35) | 33.3 ('34) |
| 506 | 1,020 ('29) | 153 ('34) | 245 | 1,770 ('15) | 1.04 ('14) | 146 | 458 ('32) | 14.4 ('34) |
| 628 | 2,490 ('26) | 210 ('34) | 427 | 4,650 ('26) | .11 ('19) | 73 | 193 ('33) | 22.4 ('32) |
| 872 | 2,770 ('26) | 219 ('34) | 372 | 3,720 ('26) | .77 ('22) | 244 | 635 ('33) | 35.6 ('32) |
| 1,437 | 3,660 ('26) | 469 ('30) | 373 | 2,700 ('26) | 5.02 ('14) | 458 | 1,140 ('31) | 48.7 ('32) |
| 2,180 | 3,340 ('28) | 383 ('33) | 459 | 2,390 ('27) | 4 ('14) | 611 | 869 ('31) | 96.6 ('33) |

# APPENDIX G—FOSSIL LISTS

## Table 1.—Ordovician Fossils

### Identified by J. S. Templeton

| Genera and Species<br>*Figured in plate 30, p. 83. | Location[e] | Platteville: Pecatonica: Deer Park 1 | Platteville: Pecatonica: Little Vermilion River 2 | Platteville: Pecatonica: Troy Grove 3 | Platteville: Mifflin: Ottawa 4 | Platteville: Mifflin: Covel Creek 5 | Platteville: Mifflin: Starved Rock 6 | Platteville: Mifflin: Deer Park 7 | Decorah: G[a]: Lowell 8 | Decorah: I[b]: Lowell 9 | Galena: P[c]: Lowell 10 | Galena: S[d]: Central 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PORIFERA | | | | | | | | | | | | |
| 1. Receptaculites oweni Hall . . . . | | | | | | | | | | | x | x |
| ANTHOZOA | | | | | | | | | | | | |
| 2. Streptelasma breve Winchell and Schuchert . . . . . . . . . . | | | | x | | | | | | | | |
| 3. Streptelasma corniculum Hall . . | | | | x | | | | | x | | | |
| 4. Streptelasma profundum (Owen) . | | | | | | | | | | x | x | |
| BRYOZOA | | | | | | | | | | | | |
| 5. Several genera and species, undetermined . . . . . . . . . . | | | x | x | x | x | x | x | x | x | x | |
| BRACHIOPODA | | | | | | | | | | | | |
| 6.*Dalmanella testudinaria (Dalman) | | | x | x | x | | x | x | x | x | x | |
| 7. Dinorthis pectinella (Emmons) . . | | | | | | | | | x | | | |
| 8. Hebertella (Glyptorthis) bellarugosa (Conrad) . . . . . . . . . . | | | | | | | | x | | | | |
| 9. Hesperorthis tricenaria (Conrad) . | | | | x | | | | | | | | |
| 10. Leptaena charlottae Winchell and Schuchert . . . . . . . . . . | | | | | | | | | x | x | | |
| 11. Lingula riciniformis Hall . . . . | | | | | | | | | | x | | |
| 12. Platystrophia biforata (Schlotheim) | | | | | | | | | x | | x | |
| 13. Plectorthis plicatella trentonensis Foerste . . . . . . . . . . | | | | | | | | | | | x | x |
| 14. Pionodema subaequata conradi (Winchell) . . . . . . . . . . | | | x | | | | | x | | | | |
| 15. Pionodema subaequata gibbosa . . | | | | | | | x | | | | | |
| 16. Rafinesquina alternata (Emmons) . | | | | | x | | | x | x | x | | x |
| 17. Rafinesquina deltoidea (Conrad) . | | | | | | | | x | | | | |
| 18. Rafinesquina minnesotensis (Winchell) . . . . . . . . . . . | | | | | x | x | x | x | x | x | x | |
| 19. Rhynchotrema increbescens (Hall) | | | | x | x | | | x | x | x | | x |
| 20. Rhynchotrema minnesotensis (Sardeson) . . . . . . . . . . | | | | | | | | | x | | | |
| 21. Scenidium anthonense Sardeson. . | | | x | | | | | | | | | |
| 22.*Sowerbyella sericeus (Sowerby) . . | | | | | | | | | x | x | x | x |
| 23.*Strophomena incurvata (Shepard) . | | | | | | x | x | | | | | |
| 24. Strophomena trentonensis Winchell and Schuchert . . . . . . . . | | | x | | | | | | | | | |
| 25. Strophomena winchelli Hall and Clarke . . . . . . . . . . . . | | | | | x | | | | | | | |
| 26. Valcourea deflecta (Conrad) . . . | | | | | | | | x | | | | |
| PELECYPODA | | | | | | | | | | | | |
| 27. Clionychia lamellosa (Hall). . . . | | | x | | | | | | | | | |
| 28. Ctenodonta gibberula Salter . . . | | | x | | | | | | | | | |
| 29. Ctenodonta nastua (Hall) . . . . | | | x | | | | | | | | | |
| 30. Cyrtodonta parva Ulrich . . . . | | | x | | | | | | | | | |
| 31. Whitella megambona (Whitfield) . | | | x | | | | | | | | | |

| | Platteville | | | | | | | Decorah | | Galena | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Pecatonica | | | Mifflin | | | | G[a] | I[b] | P[c] | S[d] |
| Genera and Species / Location[e] / *Figured in plate 30, p. 83. | Deer Park 1 | Little Vermilion River 2 | Troy Grove 3 | Ottawa 4 | Covel Creek 5 | Starved Rock 6 | Deer Park 7 | Lowell 8 | Lowell 9 | Lowell 10 | Central 11 |
| GASTROPODA | | | | | | | | | | | |
| 32. Archinacella valida (Sardeson) | | x | | | | | | | | | |
| 33. Clathrospira subconica (Hall) | | | | x | | | | | | | |
| 34. Ectomaria prisca (Billings) | | x | | | | | | | | | |
| 35. Eotomaria supracingulata (Billings) | | | | x | | | | | | | |
| 36. Fusispira nobilis Ulrich and Scofield | | | | | | | | | | x | |
| 37. Holopea parvula Ulrich | | x | | | | | | | | | |
| 38. Hormotoma gracilis (Hall) | | x | | | | | | | | | |
| 39. Liospira vitruvia (Billings) | | x | | | | | | | x | | |
| 40. Lophospira bicincta (Hall) | | x | | | | | x | | | | |
| 41. Lophospira serrulata (Salter) | | x | | | | | | | | | |
| 42. Raphistomina rugata Ulrich and Scofield | | x | | | | | | | | | |
| 43. Scenella affinis Ulrich and Scofield | | | | | | | | | | | x |
| 44. Scenella beloitensis Ulrich and Scofield | | x | | | | | | | | | |
| 45. Subulites dixonensis Ulrich and Scofield | | x | | | | | | | | | |
| 46. Tetranota bidorsata (Hall) | | x | | | | | | | | | |
| CEPHALOPODA | | | | | | | | | | | |
| 47. Cycloceras lesueuri (Clarke) | | x | | | | | | | | | |
| 48. Cyrtoceras corniculum Hall | | x | | | | | | | | | |
| 49. Orthoceras beltrami Clarke | | x | | | | | | | | | |
| 50. Orthoceras junceum Hall | | x | | | | | | | | | |
| 51. Gyroceras duplicostatum Whitfield | | | x | | | | | | | | |
| TRILOBITA | | | | | | | | | | | |
| 52. Bumastus trentonensis Emmons | | | | | | | | x | x | | |
| 53. Calymene senaria Conrad | | | | | | | | x | | | |
| 54. Encrinurus rarus (Walcott) | | | | | | | | | x | | |
| 55. Illaenus americanus (Billings) | | x | | | | | x | x | x | x | x |
| 56. Isotelus gigas de Kay | | | | | | x | x | x | x | x | x |
| 57. Pterygometopus callicephalus (Hall) | | | | | | | | | x | | x |
| 58. Pterygometopus intermedius | | x | | | | | | | | | |
| 59. Thaleops ovatus Conrad | | x | | | | | | x | x | | |
| OSTRACODA | | | | | | | | | | | |
| 60. Leperditia fabulites (Conrad) | | x | x | | | | x | | | | |
| CYSTOIDEA | | | | | | | | | | | |
| 61. Cheirocrinus logani (Billings) | | | x | | | | | | | | |

[a]G = Guttenberg.
[b]I = Ion?
[c]P = Prosser.
[d]S = Stewartville.
[e]The locations are as follows:

1. From the lower 23 feet of dolomite at the mouth of Deer Park Canyon, NE. ¼ NE. ¼ NE. ¼ sec. 31, T. 33 N., R. 2 E. (Deer Park Twp.), LaSalle quadrangle.
2. From 8 feet of dolomite in ravine on the west side of Little Vermilion River four miles north of LaSalle, SE. ¼ NE. ¼ NW. ¼ sec. 27, T. 34 N., R. 1. E. (Dimmick Twp.), LaSalle quadrangle.
3. From 12 feet of dolomite in quarry at Troy Grove, NW. ¼ SE. ¼ sec. 35, T. 35 N., R. 1 E. (Troy Grove Twp.), LaSalle quadrangle.
4. From 15 feet 6 inches of dolomitic limestone in the Aetna Sand and Gravel Company pit west of Ottawa, NW. ¼ SE. ¼ sec. 16, T. 33 N., R. 3 E. (Ottawa Twp.), Ottawa quadrangle.
5. From 13 feet of dolomitic limestone along Covel Creek three miles southwest of Ottawa, SW. ¼ NE. ¼ SE. ¼ sec 21, T. 33 N., R. 3 E. (South Ottawa Twp.), Ottawa quadrangle.
6. From 4 feet of limestone at head of Sac Canyon, half a mile southwest of Starved Rock, SE. ¼ SW. ¼ NE. ¼ sec. 21, T. 33 N., R. 2 E. (Deer Park Twp.), Ottawa quadrangle.
7. From upper 27 feet of dolomite at same locality as No. 1.
8. From lowermost strata along Vermilion River at Lowell, SE. ¼ NE. ¼ SE. ¼ sec. 8, T. 32 N., R. 2 E. (Vermilion Twp.), LaSalle quadrangle.
9. From upper part of lowermost 35 feet of dolomite exposed at same locality as No. 8.
10. From upper 115 feet of dolomite exposed at same locality as No. 8 and also down Vermilion Valley for half a mile.
11. From 35 feet of dolomitic limestone exposed in quarry at Central, SE. ¼ SW. ¼ sec. 28, T. 35 N., R. 7 E. (Lisbon Twp.), Morris quadrangle.

## Table 2.—Pennsylvanian Fossils

Identified by J. Marvin Weller

*Figured in plate 30, p. 83.

1. Limestone (Unit 13) in Lowell cyclothem, along stream in NE. ¼ SW. ¼ SW. ¼ sec. 10, T. 32 N., R. 2. E. (Deer Park Twp.), Ottawa quadrangle (geol. sec. 12).
   *Lophophyllum profundum (Milne-Edwards and Haime)
   *Derbya crassa (Meek and Hayden)
   *Mesolobus mesolobus (Norwood and Pratten)
   *Linoproductus prattenianus (Norwood and Pratten)
   *Marginifera muricatina Dunbar and Condra
   *Neospirifer triplicatus (Hall)
   *Ambocoelia planoconvexa (Shumard)

2. Hanover limestone (Unit 28) in Summum cyclothem, along stream in SW. ¼ SE. ¼ NW. ¼ sec. 10, T. 32 N., R. 2. E. (Deer Park Twp.), Ottawa quadrangle (geol. sec. 12).
   Serpulopsis sp.
   Crinoid stem fragments
   *Derbya crassa (Meek and Hayden)
   *Mesolobus mesolobus (Norwood and Pratten)
   *Linoproductus prattenianus (Norwood and Pratten)
   Dictyoclostus portlockianus (Norwood and Pratten)
   Juresania nebrascensis (Owen)?
   *Marginifera muricatina Dunbar and Condra
   *Marginifera splendens (Norwood and Pratten)
   Squamularia perlexa (McChesney)
   *Ambocoelia planoconvexa (Shumard)
   Cleiothyridina orbicularis (McChesney)
   *Composita subtilita (Hall)
   Large nautiloid cephalapod

3. Hanover limestone (Unit 28) in Summum cyclothem, along tributary to Illinois Canyon in SE. ¼ NE. ¼ NW. ¼ sec. 36, T. 33 N., R. 2 E. (Deer Park Twp.), Ottawa quadrangle.
   Crinoid stem fragments
   *Derbya crassa (Meek and Hayden)
   Chonetina flemingi (Norwood and Pratten)
   *Mesolobus mesolobus (Norwood and Pratten)
   *Linoproductus prattenianus (Norwood and Pratten)
   *Marginifera muricatina Dunbar and Condra
   *Marginifera splendens (Norwood and Pratten)
   Cleiothyridina orbicularis (McChesney)
   *Composita subtilita (Hall)

4. Limestone (Unit 37) in St. David cyclothem, along Illinois Waterway in SW. ¼ NW. ¼ NE. ¼ sec. 24, T. 33 N., R. 4 E. (Fall River Twp.), Marseilles quadrangle (geol. sec. 3).
   *Lophophyllum profundum (Milne-Edwards and Haime)
   Spirorbis carbonarius Dawson
   Serpulopsis sp.
   Crinoid stem fragments
   *Derbya crassa (Meek and Hayden)
   Chonetina flemingi (Norwood and Pratten)?
   *Mesolobus mesolobus (Norwood and Pratten)
   Lissochonetes sp.
   *Linoproductus prattenianus (Norwood and Pratten)
   Juresania nebrascensis (Owen)
   *Marginifera muricatina Dunbar and Condra
   *Composita subtilita (Hall)
   *Leda bellistriata Stevens
   Astartella sp.
   Phanerotrema grayvillensis (Norwood and Pratten)

5. Limestone (Unit 37) in St. David cyclothem, in ditch along road in SE. ¼ NE. ¼ NE. ¼ sec. 2, T. 33 N., R. 3 E. (Ottawa Twp.), Ottawa quadrangle.
   *Lophophyllum profundum (Milne-Edwards and Haime)
   Conodonts
   *Derbya crassa (Meek and Hayden)
   *Mesolobus mesolobus (Norwood and Pratten)
   *Linoproductus prattenianus (Norwood and Pratten)
   *Marginifera muricatina Dunbar and Condra
   *Composita subtilita (Hall)
   *Leda bellistriata Stevens?
   Phanerotrema grayvillensis (Norwood and Pratten)
   *Euphemites carbonarius (Cox)
   *Pharkidonotus percarinatus (Conrad)
   Pseudorthoceras knoxense (McChesney)

6. Limestone (Unit 37) in St. David cyclothem, along Little Horseshoe Canyon in NE. ¼ NW. ¼ SW. ¼ sec. 30, T. 33 N., R. 3 E. (South Ottawa Twp.), Ottawa quadrangle (geol. sec. 9).
   *Lophophyllum profundum (Milne-Edwards and Haime)
   Crinoid stem fragments
   *Derbya crassa (Meek and Hayden)
   *Mesolobus mesolobus (Norwood and Pratten)
   *Linoproductus prattenianus (Norwood and Pratten)
   *Marginifera muricatina Dunbar and Condra
   Phanerotrema grayvillensis (Norwood and Pratten)
   *Euphemites carbonarius (Cox)

7. Base of Canton shale (Unit 40) in St. David cyclothem, in abandoned shale pit in SW. ¼ NE. ¼ SW. ¼ sec. 3, T. 33 N., R. 3 E. (Ottawa Twp.), Ottawa quadrangle.
   *Lophophyllum profundum (Milne-Edwards and Haime)
   Serpulopsis sp.
   Crinoid stem fragments
   Orbiculoidea missouriensis (Shumard)
   Wellerella osagensis (Swallow)
   Nucula sp.
   Nuculopsis ventricosa (Hall)
   *Leda bellistriata Stevens
   Astartella concentrica (Conrad)
   Phanerotrema grayvillensis (Norwood and Pratten)
   Worthenia tabulata (Conrad)
   Orestes nodosus Girty
   Trepospira depressa (Cox)
   Bucanopsis meekiana (Swallow)
   *Euphemites carbonarius (Cox)
   *Pattelostium montfortianum (Norwood and Pratten)
   *Pharkidonotus percarinatus (Conrad)
   *Schizostoma catilloides (Conrad)
   *Meekospira choctawensis Girty
   Soleniscus several sp.
   Pseudorthoceras knoxense (McChesney)
   Ostracods
   Petrodus occidentalis Newberry and Worthen

8. Base of Canton shale (Unit 40) in St. David cyclothem, along Covel Creek in SE. ¼ SE. ¼ SW. ¼ sec. 26, T. 33 N., R. 3 E. (South Ottawa Twp.), Ottawa quadrangle.

*Lophophyllum profundum (Milne-Edwards and Haime)
Crinoid stem fragments
Chonetina flemingi (Norwood and Pratten)?
Nucula anodontoides Meek
Nuculopsis ventricosa (Hall)
*Leda bellistriata Stevens
Astartella concentrica (Conrad)
Phanerotrema grayvillensis (Norwood and Pratten)
Bucanopsis meekiana (Swallow)
*Euphemites carbonarius (Cox)
*Patellostium montfortianum (Norwood and Pratten)
*Pharkidonotus percarinatus (Conrad)
*Schizostoma catilloides (Conrad)
*Meekospira choctawensis Girty
Soleniscus sp.
Pseudorthoceras knoxense (McChesney)

9. Shale and argillaceous limestone (Units 55-57) in Brereton cyclothem, in road cut in SE. ¼ SE. ¼ SE. ¼ sec. 9, T. 31 N., R. 3 E. (Eagle Twp.), Streator quadrangle (geol. sec. 17).

Crinoid stem fragments
*Derbya crassa (Meek and Hayden)
Chonetes granulifer Owen
*Mesolobus mesolobus (Norwood and Pratten)
Dictyoclostus sp.
*Marginifera splendens (Norwood and Pratten)
Wellerela osagensis (Swallow)
*Neospirifer triplicatus (Hall)
*Composita subtilita (Hall)
Trepospira depressa (Cox)

10. Brereton limestone (Unit 56) in Brereton cyclothem, along stream in SE. ¼ NW. ¼ NW. ¼ and in shale pit in NE. ¼ SE. ¼ NW. ¼ sec. 7, T. 30 N., R. 4 E. (Newtown Twp.), Streator quadrangle (geol. sec. 25).

*Lophophyllum profundum (Milne-Edwards and Haime)
Crinoid stem fragments
Rhipidomella carbonaria (Swallow)
*Marginifera splendens (Norwood and Pratten)
Dielesma bovidens (Morton)
Cryptacanthia n. sp.
*Neospirifer triplicatus (Hall)
Squamularia perplexa (McChesney)
*Ambocoelia planoconvexa (Shumard)
*Composita subtilita (Hall)
Composita argentea (Shepard)
Aviculopecten interlineatus Meek and Worthen
Gosseletina spironema (Meek and Worthen)?
Porcellia gillanus White and St. John
Murchisonia sp.
Naticopsis sp.
Soleniscus sp.
Trachydoma nodosum (Meek and Worthen)
Orthonychia parva (Swallow)
Nautiloid cephalopod

# APPENDIX H—CHEMICAL ANALYSES

Compiled by H. B. Willman

Table 1.—

| Sample No. | Material | Analyst[a] | $SiO_2$ | $TiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | FeO |
|---|---|---|---|---|---|---|---|
| 1 | St. Peter sandstone . . . . . . . | . . . . . | 94.31 | 0.08 | 2.98 | 0.33 | 0.21 |
| 2 | St. Peter sandstone . . . . . . . | . . . . . | 98.47 | 0.05 | 0.75 | 0.08 | . . . . |
| 3 | St. Peter sandstone . . . . . . . | . . . . . | 99.48 | . . . . | 0.16 | 0.02 | . . . . |
| 4 | St. Peter sandstone . . . . . . . | A | 99.92 | . . . . | 0.055 | 0.015 | . . . . |
| 5 | St. Peter sandstone . . . . . . . | B | 99.607 | . . . . | 0.160 | 0.021 | . . . . |
| 6 | St. Peter sandstone . . . . . . . | . . . . . | 99.45 | . . . . | [b]0.30 | . . . . | . . . . |
| 7 | St. Peter sandstone . . . . . . . | . . . . . | 99.82 | . . . . | [b]0.05 | . . . . | . . . . |
| 8 | St. Peter sandstone . . . . . . . | . . . . . | 99.576 | . . . . | 0.283 | .0903 | . . . . |
| W-80 | Platteville limestone . . . . . . | C | 0.80 | 0.00 | 1.19 | [c]1.67 | . . . . |
| 206 | Underclay LaSalle (No. 2) coal . . | C | 49.84 | 1.45 | 33.66 | 1.04 | 0.69 |
| 211 | Underclay LaSalle (No. 2) coal . . | C | 56.00 | 2.13 | 27.72 | [c]2.00 | . . . . |
| W-28 | Underclay LaSalle (No. 2) coal . . | C | 57.42 | 1.22 | 24.73 | [c]2.29 | . . . . |
| W-29 | Underclay LaSalle (No. 2) coal . . | C | 58.56 | 1.20 | 23.88 | [c]2.80 | . . . . |
| 36 | Francis Creek shale . . . . . . . | C | 58.27 | 3.37 | 21.27 | 1.63 | 1.73 |
| 204 | Francis Creek shale . . . . . . . | C | 54.61 | 0.90 | 26.75 | 1.45 | 2.08 |
| 288 | Francis Creek shale . . . . . . . | C | 55.54 | 3.04 | 25.61 | 0.53 | 1.76 |
| W-18 | Francis Creek shale . . . . . . . | C | 61.11 | 1.13 | 20.26 | [c]4.64 | . . . . |
| W-27 | Francis Creek shale . . . . . . . | C | 56.11 | 1.01 | 23.51 | [c]5.35 | . . . . |
| W-79 | Francis Creek shale . . . . . . . | C | 55.64 | 1.00 | 23.67 | [c]4.70 | . . . . |
| 202 | Shale over Herrin (No. 6) coal . . | C | 49.50 | 1.17 | 27.60 | 2.10 | 3.37 |
| K-7 | Shale over Herrin (No. 6) coal . . | C | 59.86 | 1.91 | 17.43 | 1.42 | 5.10 |
| K-15 | Shale over Herrin (No. 6) coal . . | C | 58.03 | 1.02 | 17.72 | 2.91 | 5.77 |
| 205 | Underclay Sparland (No. 7) coal . | C | 51.96 | 1.72 | 30.60 | 1.32 | 0.80 |
| DS-91 | Marseilles till . . . . . . . . . | C | 49.58 | . . . . | 13.25 | [c]4.45 | . . . . |
| W-13 | Shelbyville clay . . . . . . . . | C | 40.36 | 0.58 | 11.80 | [c]3.60 | . . . . |

[a]Analysts—(A.) Cary and Moore; (B.) R. W. Hunt and Co.; (C.) Analytical division of Illinois State Geological Survey under direction of Dr. O. W. Rees.
[b]Includes $Fe_2O_3$. [c]Includes FeO.

Sample No. — SOURCE

1. Utica, Ill., from Boswell, P. G. H., A comparison of British and American Foundry Practice: Liverpool, p. 96, 1922, quoted in Weigel, W. M., Technology and Uses of Silica Sand. U.S. Bur. Mines, Bull. 266, p. 100, 1927. (Sample appears to have been selected from a bed unusually high in clay.)
2. Ottawa, Ill., not washed, Boswell, P. G. H., Ibid, p. 96.
3. Ottawa, Ill., washed, Boswell, P. G. H., Ibid, p. 96.
4. Wedron Silica Co., from Weigel, W. M., Ibid, p. 134.
5. Ottawa Silica Co. Mill C, formerly U.S. Silica Co., from Weigel, W. M., Ibid, p. 134.
6. Ottawa Silica Co., authority R. E. Lyons, Indiana University, from U.S. Geol. Survey, Mineral Resources 1911, pt. 2, p. 624, 1912.
7. Ottawa Silica Co., same authority and source as No. 6, p. 630.
8. American Silica Sand Co. (Reynolds quarry) formerly E. J. Reynolds and Co., by operators of quarry, from U.S. Geol. Survey, Min. Res. 1911, pt. 2, pp. 624, 630, 1912.

W-80. Platteville limestone, 13 feet thick, along Covel Creek in NE. ¼ SE. ¼ sec. 21, T. 33 N., R. 3 E. (South Ottawa Twp.), LaSalle County, Ottawa quadrangle.

206. Underclay LaSalle (No. 2) coal, fraction finer than 2 microns, Chicago Retort and Firebrick Co., Ottawa, NE. ¼ SE. ¼ sec. 6, T. 33 N., R. 4 E. (Rutland Twp.), LaSalle County, Ottawa quadrangle. Source—same as 36.

211. Underclay LaSalle (No. 2) coal, upper 8 feet only, fraction finer than 2 microns, Conco-Meier Co., Lowell, NE. ¼ SW. ¼ SW. ¼ sec. 9, T. 32 N., R. 2 E. (Vermilion Twp.), LaSalle County, LaSalle quadrangle. Sample collected by R. E. Grim.

W-28. Underclay LaSalle (No. 2) coal, upper 1 foot, same location as W-27.

W-29. Underclay LaSalle (No. 2) coal, 2 feet thick, from 1 to 3 feet below coal, same location as W-27.

36. Francis Creek shale, fraction finer than 2 microns, outcrop, center NW. ¼ sec. 32, T. 34 N., R. 4 E. (Dayton Twp.), LaSalle County, Ottawa quadrangle. Source—R. E. Grim, Petrology of the Pennsylvanian

Rock Analyses

| MgO | CaO | $Na_2O$ | $K_2O$ | $P_2O_5$ | S | $H_2O+$ | $H_2O-$ | $CO_2$ | Loss on Ignition | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| 0.36 | 0.19 | 0.11 | 0.18 | .... | .... | .... | .... | 1.49 | .... | 100.24 |
| 0.08 | 0.21 | 0.00 | 0.06 | .... | .... | .... | .... | 0.47 | .... | 100.17 |
| 0.05 | 0.11 | 0.00 | 0.00 | .... | .... | .... | .... | 0.13 | .... | 99.95 |
| 0.01 | .... | .... | .... | .... | .... | .... | .... | .... | .... | 100.000 |
| 0.030 | 0.050 | .... | .... | .... | .... | .... | .... | .... | .080 | 99.948 |
| Tr. | 0.13 | .... | .... | .... | .... | .... | .... | .... | .... | 99.88 |
| .... | 0.13 | .... | .... | .... | .... | .... | .... | .... | .... | 100.00 |
| 0.002 | 0.0197 | .... | .... | .... | .... | .... | .... | .... | .... | 99.9710 |
| 8.31 | 43.73 | Tr. | Tr. | .... | 0.12 | .... | 0.02 | 43.72 | 44.13 | 99.95 |
| 0.47 | 0.62 | 0.11 | 0.21 | .... | .... | 12.21 | 1.24 | .... | 12.13 | 100.22 |
| 0.35 | 0.57 | 0.11 | 2.13 | .... | .... | 9.46 | 2.66 | .... | 9.75 | 100.76 |
| 0.80 | 0.65 | 0.00 | 0.82 | .... | 0.12 | .... | 1.85 | 0.19 | 12.52 | 100.57 |
| 0.22 | 0.67 | 0.00 | 0.89 | .... | 0.85 | .... | 2.07 | 0.00 | 11.63 | 100.70 |
| 1.23 | 0.94 | 0.93 | 3.93 | 0.80 | .... | .... | 0.25 | .... | 5.91 | 100.01 |
| 2.16 | 0.48 | 0.83 | 4.84 | .... | .... | 6.06 | 0.85 | .... | 6.69 | 100.79 |
| 1.09 | 0.51 | 0.70 | 3.64 | 0.47 | .... | .... | 0.63 | .... | 7.33 | 100.22 |
| 1.54 | 0.93 | 0.67 | 4.26 | .... | 0.05 | .... | 0.30 | 0.96 | 5.66 | 100.25 |
| 1.42 | 1.36 | 0.41 | 4.08 | .... | 0.24 | .... | 0.51 | 1.25 | 6.70 | 100.19 |
| 1.77 | 0.31 | 0.44 | 4.66 | .... | 0.68 | .... | 0.69 | 0.07 | 7.10 | 99.97 |
| 2.66 | 1.49 | 0.51 | 4.57 | .... | .... | 7.66 | 1.32 | .... | 7.74 | 100.70 |
| 2.32 | 1.05 | 0.18 | 2.80 | .... | 0.13 | .... | 0.20 | .... | 6.35 | 98.75 |
| 1.43 | 1.42 | 1.40 | 2.66 | .... | 0.25 | .... | 0.97 | .... | 6.47 | 100.05 |
| 1.09 | 0.97 | 0.31 | 1.94 | .... | .... | 9.98 | .... | .... | 10.00 | 100.71 |
| 6.50 | 9.43 | .... | .... | .... | .... | .... | 0.48 | 12.69 | 16.75 | 99.96 |
| 5.11 | 13.69 | 0.54 | 2.93 | .... | Tr. | .... | 2.09 | 16.45 | 21.48 | 100.09 |

shales and noncalcareous underclays associated with Illinois coals: Am. Ceramic Soc., Vol. 14, p. 133, 1935.

204. Francis Creek shale, fraction finer than 2 microns, Chicago Retort and Firebrick Co., Ottawa, NE. ¼ SE. ¼ sec. 6, T. 33 N., R. 4 E. (Rutland Twp.), LaSalle County, Ottawa quadrangle. Source—same as 36.

288. Francis Creek shale, fraction finer than 2 microns, Herrick Clay Manufacturing Co. pit (now abandoned) at Buffalo Rock west of Ottawa, SW. ¼ NE. ¼ SE. ¼ sec. 18, T. 33 N., R. 3 E. (Ottawa Twp.), LaSalle County, Ottawa quadrangle. Source—same as 36.

W-18. Francis Creek shale, 15 feet thick, Fox River Clay Works, near Dayton, in NW. ¼ SE. ¼ NW. ¼ sec. 32, T. 34 N., R. 4 E. (Dayton Twp.), LaSalle County, Ottawa quadrangle.

W-27. Francis Creek shale, 25 feet thick, sampled in local mine shaft, near Marseilles, SE. ¼ NW. ¼ SE. ¼ sec. 10, T. 33 N., R. 4 E. (Rutland Twp.), LaSalle County, Marseilles quadrangle.

W-79. Francis Creek shale, lower 12 feet, at Buffalo Rock in SW. ¼ NE. ¼ SE. ¼ sec. 18, T. 33 N., R. 3 E. (Ottawa Twp.), LaSalle County, Ottawa quadrangle.

202. Shale over Herrin (No. 6) coal, fraction finer than 2 microns, Streator Clay Products Company, Streator, NW. ¼ NW. ¼ sec. 7, T. 30 N., R. 4 E. (Newtown Twp.), Livingston County, Streator quadrangle. Source—same as 36.

K-7. Shale over Herrin (No. 6) coal, Streator Paving Brick Co., (now Streator Brick Co.), SW. ¼ NE. ¼ sec. 35, T. 31 N., R. 3 E. (Bruce Twp.), LaSalle County, Ottawa quadrangle. Source—Rolfe, C. W., Purdy, R. C., Talbot, A. N., and Baker, I. O., Paving Brick and Paving Brick Clays of Illinois: Illinois Geol. Survey Bull. 9, p. 284, 1908.

K-15. Shale over Herrin (No. 6) coal, Barr Clay Co. (now Purington Paving Brick Co.), NW. ¼ NE. ¼ sec. 12, T. 30 N., R. 3 E. (Reading Twp.), Livingston County, Streator quadrangle. Source—same as K-7.

205. Underclay Sparland (No. 7) coal, fraction finer than 2 microns, Streator Clay Products Company, Streator, NW. ¼ NE. ¼ sec. 18, T. 30 N., R. 4 E. (Newtown Twp.), Livingston County, Streator quadrangle. Source—same as 36.

DS-91. Marseilles till, 25 feet thick, near Seneca, in SE. ¼ NW. ¼ SE. ¼ sec. 30, T. 33 N., R. 6 E. (Norman Twp.), Grundy County, Marseilles quadrangle.

W-13. Glacial clay (Lake Kickapoo deposit), 12 feet thick, Wedron Silica Co., SE. ¼ SE. ¼ NW. ¼ sec. 9, T. 34 N., R. 4 E. (Dayton Twp.), LaSalle County, Ottawa quadrangle (geologic section 68).

TABLE 2.—COAL ANALYSES[a]

| Coal No. | Town Near | Year Sampled | Character of Sample | Lab. No. | Condition[b] | Proximate: Moisture | Proximate: Volatile Matter | Proximate: Fixed Carbon | Proximate: Ash | Ultimate: Hydrogen | Ultimate: Carbon | Ultimate: Nitrogen | Ultimate: Oxygen | Ultimate: Sulphur: Sul-phate | Ultimate: Sulphur: Pyritic | Ultimate: Sulphur: Organic | Ultimate: Sulphur: Total | Ultimate: Ash | Mineral Carbon Dioxide | Heat Values: Calories | Heat Values: British Thermal Units | Heat Values: Rank Index | Heat Values: Unit Coal Index | Heat Values: Fusion Point of Ash °F. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2 | Ottawa | 1940 | Face | C-2304 | 1 | 11.6 | 39.8 | 40.4 | 8.2 | | | | | 0.05 | 4.15 | 2.34 | 6.54 | | | 6,337 | 11,408 | | | 2,372 |
| | | | | | 2 | | 45.0 | 45.7 | 9.3 | | | | | 0.06 | 4.70 | 2.64 | 7.40 | | | 7,173 | 12,912 | | | |
| | | | | | 3 | | 49.6 | 50.4 | | | | | | 0.07 | 5.18 | 2.91 | 8.16 | | | 7,904 | 14,228 | | | |
| | | | | | 4 | 13.2 | 41.7 | 45.1 | | | | | | | | | | | | 7,032 | 12,658 | 127 | | |
| | | | | | 5 | | 48.1 | 51.9 | | | | | | | | | | | | 8,112 | 14,602 | | 147 | |
| 2 | Ottawa | 1940 | Face | C-2305 | 1 | 12.7 | 40.9 | 39.4 | 7.0 | | | | | 0.04 | 2.81 | 2.57 | 5.42 | | | 6,432 | 11,578 | | | 2,345 |
| | | | | | 2 | | 46.8 | 45.2 | 8.0 | | | | | 0.05 | 3.22 | 2.93 | 6.20 | | | 7,367 | 13,261 | | | |
| | | | | | 3 | | 50.9 | 49.1 | | | | | | 0.06 | 3.50 | 3.18 | 6.74 | | | 8,010 | 14,418 | | | |
| | | | | | 4 | 14.2 | 42.7 | 43.1 | | | | | | | | | | | | 7,022 | 12,639 | 126 | | |
| | | | | | 5 | | 49.7 | 50.3 | | | | | | | | | | | | 8,180 | 14,725 | | 147 | |
| 2 | Ottawa | 1940 | Composite of C-2304, and C-2305 | C-2306 | 1 | 12.0 | 40.6 | 39.7 | 7.7 | 5.99 | 61.84 | 0.93 | 17.55 | 0.04 | 3.52 | 2.44 | 6.00 | 7.69 | 0.08 | 6,410 | 11,538 | | | 2,361 |
| | | | | | 2 | | 46.2 | 45.1 | 8.7 | 5.29 | 70.31 | 1.06 | 7.77 | 0.05 | 4.00 | 2.77 | 6.82 | 8.75 | 0.09 | 7,288 | 13,119 | | | |
| | | | | | 3 | | 50.6 | 49.4 | | 5.79 | 77.01 | 1.16 | 8.57 | 0.06 | 4.38 | 3.03 | 7.47 | | 0.10 | 7,982 | 14,368 | | | |
| | | | | | 4 | 13.6 | 42.5 | 43.9 | | | | | | | | | | | | 7,064 | 12,715 | 127 | | |
| | | | | | 5 | | 49.2 | 50.8 | | | | | | | | | | | | 8,174 | 14,713 | | 147 | |
| 2 | Ottawa | 1940 | Face | C-2307 | 1 | 14.0 | 37.2 | 37.8 | 11.0 | | | | | 0.11 | 6.52 | 1.59 | 8.22 | | | 5,879 | 10,583 | | | 2,569 |
| | | | | | 2 | | 43.3 | 43.9 | 12.8 | | | | | 0.12 | 7.59 | 1.85 | 9.56 | | | 6,837 | 12,307 | | | |
| | | | | | 3 | | 49.6 | 50.4 | | | | | | 0.14 | 8.71 | 2.13 | 10.98 | | | 7,848 | 14,126 | | | |
| | | | | | 4 | 16.7 | 39.5 | 43.8 | | | | | | | | | | | | 6,760 | 12,169 | 122 | | |
| | | | | | 5 | | 47.5 | 52.5 | | | | | | | | | | | | 8,121 | 14,618 | | 146 | |
| 2 | Ottawa | 1940 | Face | C-2308 | 1 | 14.8 | 35.6 | 40.5 | 9.1 | | | | | 0.07 | 4.81 | 1.43 | 6.31 | | | 5,967 | 10,741 | | | 2,569 |
| | | | | | 2 | | 41.8 | 47.5 | 10.7 | | | | | 0.08 | 5.65 | 1.69 | 7.42 | | | 7,008 | 12,614 | | | |
| | | | | | 3 | | 46.8 | 53.2 | | | | | | 0.09 | 6.33 | 1.88 | 8.30 | | | 7,845 | 14,121 | | | |
| | | | | | 4 | 17.1 | 37.3 | 45.6 | | | | | | | | | | | | 6,680 | 12,025 | 120 | | |
| | | | | | 5 | | 45.0 | 55.0 | | | | | | | | | | | | 8,063 | 14,513 | | 145 | |
| 2 | Ottawa | 1940 | Composite of C-2307 and C-2308 | C-2309 | 1 | 14.2 | 36.2 | 39.5 | 10.1 | 5.74 | 57.86 | 0.99 | 18.16 | 0.08 | 5.59 | 1.48 | 7.15 | 10.10 | 0.24 | 5,989 | 10,780 | | | 2,569 |
| | | | | | 2 | | 42.3 | 45.9 | 11.8 | 4.84 | 67.48 | 1.15 | 6.42 | 0.09 | 6.52 | 1.73 | 8.34 | 11.77 | 0.28 | 6,985 | 12,573 | | | |
| | | | | | 3 | | 47.9 | 52.1 | | 5.49 | 76.44 | 1.31 | 7.31 | 0.10 | 7.38 | 1.97 | 9.45 | | 0.31 | 7,913 | 14,244 | | | |
| | | | | | 4 | 16.7 | 38.2 | 45.1 | | | | | | | | | | | | 6,799 | 12,239 | 122 | | |
| | | | | | 5 | | 46.0 | 54.0 | | | | | | | | | | | | 8,169 | 14,704 | | 147 | |
| 2 | LaSalle County (west of LaSalle anticline) | | Average of 6 mine averages (1 ultimate) | c | 1 | 14.5 | 38.4 | 38.8 | 8.3 | 5.8 | 61.6 | 1.0 | 20.0 | | | | 3.3 | | | 6,136 | 11,050 | | | |
| | | | | | 2 | | 44.9 | 45.4 | 9.7 | 4.9 | 72.0 | 1.2 | 8.3 | | | | 3.9 | | | 7,177 | 12,920 | | | |
| | | | | | 3 | | 49.7 | 50.3 | | 5.4 | 79.8 | 1.3 | 9.2 | | | | 4.3 | | | 7,947 | 14,310 | | | |
| | | | | | 4 | 16.3 | 40.8 | 42.9 | | | | | | | | | | | | 6,774 | 12,190 | | | |
| | | | | | 5 | | 48.7 | 51.3 | | | | | | | | | | | | 8,089 | 14,560 | | | |
| Unit 43—Local coal below coal No. 6 | Streator | 1938 | Face | C-2054 | 1 | 15.9 | 35.0 | 43.1 | 6.0 | | | | | | | | 1.78 | | | 6,298 | 11,338 | | | 2,168 |
| | | | | | 2 | | 41.7 | 51.2 | 7.1 | | | | | | | | 2.11 | | | 7,490 | 13,482 | | | |
| | | | | | 3 | | 44.8 | 55.2 | | | | | | | | | 2.28 | | | 8,060 | 14,510 | | | |
| | | | | | 4 | 17.2 | 36.5 | 46.3 | | | | | | | | | | | | 6,753 | 12,156 | 122 | | |
| | | | | | 5 | | 44.2 | 55.8 | | | | | | | | | | | | 8,150 | 14,671 | | 147 | |
| Unit 43—Local coal below coal No. 6 | Streator | 1938 | Face | C-2055 | 1 | 15.2 | 35.8 | 43.0 | 6.0 | | | | | | | | 1.65 | | | 6,379 | 11,481 | | | 2,185 |
| | | | | | 2 | | 42.2 | 50.7 | 7.1 | | | | | | | | 1.94 | | | 7,520 | 13,536 | | | |
| | | | | | 3 | | 45.4 | 54.6 | | | | | | | | | 2.09 | | | 8,098 | 14,576 | | | |
| | | | | | 4 | 16.4 | 37.4 | 46.2 | | | | | | | | | | | | 6,838 | 12,308 | 123 | | |
| | | | | | 5 | | 44.8 | 55.2 | | | | | | | | | | | | 8,181 | 14,726 | | 147 | |

| | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Unit 43—Local coal below coal No. 6 | Streator | 1938 | Face | C-2056 | 1 | 15.3 | 35.1 | 43.1 | 6.5 | | | | | | | | 2.15 | | | 6,308 | 11,355 | | | 2,143 |
| | | | | | 2 | | 41.5 | 50.8 | 7.7 | | | | | | | | 2.54 | | | 7,450 | 13,411 | | | |
| | | | | | 3 | | 45.0 | 55.0 | | | | | | | | | 2.76 | | | 8,074 | 14,533 | | | |
| | | | | | 4 | 16.7 | 36.7 | 46.6 | | | | | | | | | | | | 6,807 | 12,252 | 122 | | |
| | | | | | 5 | | 44.2 | 55.8 | | | | | | | | | | | | 8,174 | 14,714 | | 147 | |
| Unit 43—Local coal below coal No. 6 | Streator | 1938 | Composite of C-2054, C-2055 and C-2056 | C-2057 | 1 | 15.4 | 35.2 | 43.2 | 6.2 | 6.35 | 63.31 | 1.12 | 21.20 | | | | 1.86 | 6.16 | | 6,316 | 11,368 | | | 2,168 |
| | | | | | 2 | | 41.7 | 51.0 | 7.3 | 5.51 | 74.88 | 1.33 | 8.79 | | | | 2.20 | 7.29 | | 7,469 | 13,444 | | | |
| | | | | | 3 | | 45.0 | 55.0 | | 5.94 | 80.75 | 1.43 | 9.51 | | | | 2.37 | | | 8,055 | 14,499 | | | |
| | | | | | 4 | 16.7 | 36.8 | 46.5 | | | | | | | | | | | | 6,788 | 12,218 | 122 | | |
| | | | | | 5 | | 44.3 | 55.7 | | | | | | | | | | | | 8,148 | 14,667 | | 147 | |
| 6 | Streator[d] | 1912 | Face | 5414[e] | 1 | 12.87 | 42.40 | 37.35 | 7.38 | | | | | | | | 3.86 | | .00 | | 11,468 | | | |
| | | | | | 2 | | 48.67 | 42.86 | 8.47 | | | | | | | | 4.44 | | .00 | | 13,161 | | | |
| | | | | | 3 | | 53.17 | 46.83 | | | | | | | | | 4.85 | | | | 14,379 | | | |
| | | | | | 5 | | | | | | | | | | | | | | | | 14,635 | | 146 | |
| 6 | Streator[d] | 1912 | Face | 5416[e] | 1 | 13.82 | 41.42 | 35.90 | 8.86 | | | | | | | | 3.95 | | .51 | | 11,174 | | | |
| | | | | | 2 | | 48.06 | 41.67 | 10.27 | | | | | | | | 4.58 | | .59 | | 12,966 | | | |
| | | | | | 3 | | 53.56 | 46.44 | | | | | | | | | 5.10 | | .66 | | 14,450 | | | |
| | | | | | 5 | | | | | | | | | | | | | | | | 14,744 | | 147 | |
| 6 | Streator[d] | 1912 | Face | 5417[e] | 1 | 13.99 | 38.81 | 40.12 | 7.08 | | | | | | | | 3.23 | | .00 | | 11,401 | | | |
| | | | | | 2 | | 45.12 | 46.65 | 8.23 | | | | | | | | 3.76 | | .00 | | 13,255 | | | |
| | | | | | 3 | | 49.17 | 50.83 | | | | | | | | | 4.10 | | .00 | | 14,444 | | | |
| | | | | | 5 | | | | | | | | | | | | | | | | 14,675 | | 147 | |
| 6 | Streator[d] | 1912 | Average of 5414-16-17 | f | 1 | 13.6 | 40.9 | 37.8 | 7.7 | | | | | | | | 3.7 | | | 6,304 | 11,350 | | | |
| | | | | | 2 | | 47.3 | 43.7 | 9.0 | | | | | | | | 4.3 | | | 7,293 | 13,130 | | | |
| | | | | | 3 | | 52.0 | 48.0 | | | | | | | | | 4.7 | | | 8,013 | 14,420 | | | |
| | | | | | 4 | 15.1 | 43.3 | 41.6 | | | | | | | | | | | | 6,923 | 12,460 | 125 | | |
| | | | | | 5 | | 51.0 | 49.0 | | | | | | | | | | | | 8,158 | 14,680 | | 147 | |
| 6 | Streator | 1934 | Face | C-869[e] | 1 | 13.3 | 38.0 | 39.1 | 9.6 | | | | | | | | 3.65 | | .67 | | 11,065 | | | 2,097 |
| | | | | | 2 | | 43.8 | 45.1 | 11.1 | | | | | | 2.4 | 1.7 | 4.21 | | .77 | | 12,763 | | | |
| | | | | | 3 | | 49.2 | 50.8 | | | | | | | | | 4.74 | | | | 14,349 | | | |
| | | | | | 5 | | | | | | | | | | | | | | | | 14,647 | | 146 | |
| 6 | Streator | 1934 | Face | C-870[e] | 1 | 13.2 | 38.4 | 39.1 | 9.3 | | | | | | | | 3.67 | | .55 | | 11,139 | | | 2,006 |
| | | | | | 2 | | 44.2 | 45.0 | 10.8 | | | | | | 2.6 | 1.5 | 4.23 | | .64 | | 12,833 | | | |
| | | | | | 3 | | 49.5 | 50.5 | | | | | | | | | 4.74 | | | | 14,381 | | | |
| | | | | | 5 | | | | | | | | | | | | | | | | 14,674 | | 147 | |
| 6 | Streator | 1934 | Face | C-871[e] | 1 | 12.3 | 38.1 | 40.1 | 9.5 | | | | | | | | 3.53 | | .43 | | 11,163 | | | 2,144 |
| | | | | | 2 | | 43.5 | 45.6 | 10.9 | | | | | | 2.5 | 1.4 | 4.03 | | .49 | | 12,733 | | | |
| | | | | | 3 | | 48.8 | 51.2 | | | | | | | | | 4.52 | | | | 14,289 | | | |
| | | | | | 5 | | | | | | | | | | | | | | | | 14,570 | | 146 | |
| 6 | Streator | 1934 | Composite of C-869, C-870 and C-871 | C-872[f] | 1 | 12.8 | 38.2 | 39.5 | 9.5 | 5.8 | 61.1 | 1.0 | 19.0 | | | | 3.6 | | | 6,193 | 11,150 | | | 2,128 |
| | | | | | 2 | | 43.8 | 45.3 | 10.9 | 5.0 | 70.1 | 1.1 | 8.7 | | 2.6 | 1.5 | 4.2 | | | 7,104 | 12,790 | | | |
| | | | | | 3 | | 49.2 | 50.8 | | 5.6 | 78.7 | 1.3 | 9.8 | | | | 4.6 | | | 7,970 | 14,350 | | | |
| | | | | | 4 | 14.6 | 41.0 | 44.4 | | | | | | | | | | | | 6,944 | 12,500 | 125 | | |
| | | | | | 5 | | 48.0 | 52.0 | | | | | | | | | | | | 8,132 | 14,640 | | 146 | |
| 7 | Marshall County | | Average of 6 mine averages (2 ultimates) | g | 1 | 15.3 | 35.3 | 35.3 | 14.1 | 5.7 | 55.5 | 1.0 | 20.2 | | | | 3.5 | | | 5,585 | 10,050 | | | |
| | | | | | 2 | | 41.6 | 41.7 | 16.7 | 4.7 | 65.5 | 1.2 | 7.8 | | | | 4.1 | | | 6,591 | 11,870 | | | |
| | | | | | 3 | | 50.0 | 50.0 | | 5.6 | 78.6 | 1.4 | 9.4 | | | | 5.0 | | | 7,912 | 14,240 | | | |
| | | | | | 4 | 18.5 | 39.5 | 42.0 | | | | | | | | | | | | 6,625 | 11,920 | 119 | | |
| | | | | | 5 | | 48.5 | 51.5 | | | | | | | | | | | | 8,126 | 14,630 | | 146 | |

[a]Analyses by Geochemical Section, Illinois Geological Survey, under supervision of O. W. Rees, except Nos. 5414, 5416, 5417 by Chemical Testing Laboratory University of Illinois.
[b]The form of analysis is denoted by number, as follows: 1 = samples as received at laboratory; 2 = moisture-free; 3 = moisture- and ash-free; 4 = moist mineral-matter-free; 5 = dry mineral-matter-free (Unit Coal).
[c]Cady, G. H., Classification and selection of Illinois coals: Illinois Geol. Survey Bull. 62, p. 219, 1935.
[d]Chicago, Wilmington, and Vermilion Coal Co. Mine No. 3 (abandoned).
[e]Cady, G. H., op. cit., p. 131. [f]Cady, G. H., op. cit., p. 251. [g]Cady, G. H., op. cit., p. 289.

# APPENDIX J—CERAMIC TESTS

Compiled by
H. B. Willman

## SUMMARY OF MATERIALS TESTED

| *Sample* | *Material* |
|---|---|
| W-28 | Underclay LaSalle (No. 2) coal |
| W-29 | Underclay LaSalle (No. 2) coal |
| W-18 | Francis Creek shale |
| W-27 | Francis Creek shale |
| W-79 | Francis Creek shale |
| W-3 | Underclay Summum (No. 4) coal |
| W-1 | Canton shale |
| 25 | Shale over Herrin (No. 6) coal |
| K-15 | Shale over Herrin (No. 6) coal |
| 205 | Underclay Sparland (No. 7) coal |

## SAMPLE — W-28

Material—Underclay of LaSalle (No. 2) coal.

Thickness sampled—1 foot, represents upper 1 foot of clay reported to be at least 9 feet thick.

Location—Sampled in mine, at depth of 92 feet, SE. ¼ NW. ¼ SE. ¼ sec. 10, T. 33 N., R. 4 E. (Rutland Twp.), LaSalle County, Marseilles quadrangle. Mine now abandoned.

Test by—Ceramic Engineering Dept., University of Illinois, for State Geological Survey.

### RESULTS OF TESTS

This material is a black fireclay which has a hackly fracture, good plasticity over a satisfactory range, and requires 34.0 per cent water to develop its normal medium working consistency. A medium bonding strength is indicated by a value of 303 lb. per sq. in. for the modulus of rupture. It dries slowly under ordinary atmospheric conditions, scums heavily, and has a shrinkage of 13.1 per cent. When slaked and washed on a 40-mesh sieve, 4.9 per cent residue remains which consists largely of unslaked original material, calcite, quartz grains, and coarse pyrites. Further screen analysis of the material shows: 1.2 per cent residue on 48-mesh, 4.6 per cent on 65-mesh, 9.3 per cent on 100-mesh, and 84.9 per cent through 100-mesh. Treatment with cold hydrochloric acid causes mild evolution of gas indicating the presence of carbonates.

Burning Test

| Cone | Porosity per cent | Color | Hardness | Linear burning shrinkage per cent | Total linear shrinkage per cent |
|---|---|---|---|---|---|
| 05 | 24.0 | light yellow | | 4.5 | 17.6 |
| 01 | 23.9 | light yellow | | 5.3 | 18.4 |
| 1 | 22.3 | light yellow | steel hard | 5.0 | 18.1 |
| 2 | 21.4 | light yellow | steel hard | 5.6 | 18.7 |
| 3 | 20.8 | light yellow | steel hard | 5.6 | 18.7 |
| 6 | 20.7 | buff | steel hard | 5.3 | 18.4 |
| 8 | 16.2 | buff | steel hard | 5.9 | 19.0 |
| 9 | 17.6 | buff | steel hard | 6.1 | 19.2 |
| 12 | 16.6 | tan | steel hard | 6.3 | 19.4 |
| 14 | 13.7 | brown | steel hard | 6.4 | 19.5 |

This is a refractory material which vitrifies slowly and incompletely up to cone 14. Its P.C.E. value lies between cone 28 and 29. It oxidizes with considerable difficulty. The total shrinkage changes very slowly and is high. The color is light yellow throughout a wide range then becomes buff, tan, and brown. Soluble salts appear on the dry samples and are conspicuous on the pieces burned at cone 6.

Suggested uses: Refractories for moderate requirements, common brick, structural tile, and if soluble salts can be controlled, face brick and architectural terra cotta.

SAMPLE — W-29

Material—Underclay of LaSalle (No. 2) coal.

Thickness sampled—2 feet, from 1 to 3 feet below base of coal.

Location—Same as W-28.

Test by—Ceramic Engineering Dept., University of Illinois, for State Geological Survey.

RESULTS OF TESTS

The material is a fireclay containing pyritic and bituminous concretions. It is grayish-black in color, has a hackly fracture, good plasticity over a satisfactory range, and requires 32.3 per cent water to develop its normal medium working consistency. A low medium bonding strength is indicated by the value 192 lb. per sq. in. for the modulus of rupture. It dries slowly under ordinary atmospheric conditions without difficulty, scums considerably, and has a shrinkage of 12.9 per cent. When slaked and washed on a 40-mesh sieve, 4.9 per cent residue remains which consists of unslaked original material, large and small pyrite grains and some bituminous material. Further screen analysis of the material shows 1.1 per cent residue on 48-mesh; 5.9 per cent on 65-mesh; 9.9 on 100-mesh; and 83.1 per cent through 100-mesh. Treatment with cold and hot hydrochloric acid causes no evolution of gas indicating the absence of carbonates.

BURNING TEST

| Cone | Porosity per cent | Color | Hardness | Linear burning shrinkage per cent | Total linear shrinkage per cent |
|---|---|---|---|---|---|
| 05 | 22.4 | gray-white | steel hard | 3.9 | 16.8 |
| 02 | 20.3 | yellow-white | steel hard | 4.8 | 17.7 |
| 01 | 20.1 | light yellow | steel hard | 4.9 | 17.8 |
| 2 | 18.8 | light yellow | steel hard | 5.4 | 18.3 |
| 3 | 17.7 | light yellow | steel hard | 5.5 | 18.4 |
| 6 | 16.8 | buff | steel hard | 5.3 | 18.2 |
| 8 | 15.3 | buff | steel hard | 5.5 | 18.4 |
| 9 | 13.7 | buff | steel hard | 5.7 | 18.6 |
| 12 | 12.5 | tan | steel hard | 6.2 | 19.1 |
| 14 | 11.0 | tan | steel hard | 6.1 | 19.0 |

This is a refractory clay of medium grade. Its P.C.E. value lies between cones 28-30. It oxidizes with considerable difficulty. It burns quite uniformly yellow in color to cone 3 and buff to cone 9. The porosity changes are gradual and it is not vitrified at cone 14. The total shrinkages are high throughout this range.

Suggested uses: The presence of soluble salts as well as pyrite particles and poor oxidizing conduct may be detrimental for many uses, otherwise the clay should be serviceable for refractories, brick, and structural tile.

SAMPLE — W-18

Material—Francis Creek shale.

Thickness sampled—15 feet.

Company—Fox River Clay Works.

Location—One-half mile southwest of Dayton, SE. ¼ NW. ¼ sec. 32, T. 34 N., R. 4 E. (Dayton Twp.), LaSalle County, Ottawa quadrangle.

Test by—Ceramic Engineering Dept., University of Illinois, for State Geological Survey.

RESULTS OF TESTS

The material is a hard, slightly stratified clay which is gray in color, has an irregular conchoidal fracture, has medium plasticity over a moderate range, and requires 30.4 per cent water to develop its normal soft working consistency. A value of 178 lb. per sq. in. for the modulus of rupture indicates a low medium bonding strength. It dries slowly under ordinary atmospheric conditions and has a shrinkage of 6.8 per cent. When slaked and washed on a 40-mesh sieve, 22.5 per cent residue remains which consists of unslaked gray material, some sand bonded with lime, and some red-brown iron minerals bonded with brown substance. Treatment with cold hydrochloric acid causes generous evolution of gas indicating the presence of carbonates.

BURNING TEST

| Cone | Porosity per cent | Color | Hardness | Linear burning shrinkage per cent | Total linear shrinkage per cent |
|---|---|---|---|---|---|
| 04 | 2.7 | lt. choc. brown | steel hard | 10.6 | 17.4 |
| 02 | 0.6 | lt. choc. brown | steel hard | 10.8 | 17.6 |
| 1 | 0.0 | lt. choc. brown | steel hard | 10.9 | 17.7 |
| 2 | 0.2 | lt. choc. brown | steel hard | 10.9 | 17.7 |
| 3 | 0.0 | darker | steel hard | 10.6 | 17.4 |
| 6 | 0.4 | rough | steel hard | 7.5 | 14.3 |
| 8 | 6.1 | lime gray br'n | steel hard | 1.1 | 7.9 |

The clay oxidizes readily. It burns to a practically nonporous or well vitrified body from cone 02 to and including cone 6. Above this temperature it apparently overburns. The shrinkages are high and practically constant from cone 04 to cone 3 inclusive. At cone 6 there are indications of overburning. Soluble salts appear on the pieces burned at the lowest temperatures which possibly may be corrected.

Suggested uses: Common brick, drain and structural tile (if soluble salts can be avoided).

SAMPLE — W-27

Material—Francis Creek shale.

Thickness sampled—15 feet.

Location—Same as W-28, sampled in shaft of mine at depth of 75 to 90 feet.

Test by—Ceramic Engineering Dept., University of Illinois, for State Geological Survey.

RESULTS OF TESTS

The material is a fairly hard shale which is dark gray in color, has a conchoidal fracture, fair plasticity over a moderate range, and requires 30.4 per cent water to develop its normal medium soft working consistency. A low medium bonding strength is indicated by the value 179 lb. per sq. in. for the modulus of rupture. It dries slowly under ordinary atmospheric conditions without difficulty, scums somewhat, and has a shrinkage of 7.6 per cent. When slaked and washed on a 40-mesh sieve, 57.7 per cent residue remains which consists of unslaked original material. Treatment with cold and hot hydrochloric acid causes no evolution of gas indicating the absence of carbonates.

BURNING TEST

| Cone | Porosity per cent | Color | Hardness | Linear burning shrinkage per cent | Total linear shrinkage per cent |
|---|---|---|---|---|---|
| 04 | 0.4 | reddish chocolate brown | steel hard | 10.9 | 18.5 |
| 01 | 0.4 | reddish chocolate brown | steel hard | 10.8 | 18.4 |
| 1 | 0.3 | reddish chocolate brown | steel hard | 10.6 | 18.2 |
| 2 | 0.3 | reddish chocolate brown | steel hard | 10.6 | 18.2 |
| 3 | 0.0 | darker brown | steel hard | 9.3 | 16.9 |
| 6 | 12.7 | glassy brown overburned | steel hard | 2.7 | 10.3 |

This material oxidizes readily. It is vitrified throughout the range cone 04 to cone 3. It is overburned slightly at the latter cone and decidedly at cone 6. The color is quite uniform throughout a wide range. The total shrinkages are high. The presence of soluble salts is to be noted.

Suggested uses: Common brick, drain tile, structural tile, and if the soluble salts can be controlled, face brick.

SAMPLE — W-79

Material—Francis Creek shale.

Thickness sampled—11½ feet.

Location—Buffalo Rock, NE. ¼ SE. ¼ sec. 18, T. 33 N., R. 3 E. (Ottawa Twp.), LaSalle County, Ottawa quadrangle. Abandoned pit formerly operated by Herrick Clay Mfg. Co.

Tests by—Ceramic Engineering Dept., University of Illinois, for State Geological Survey.

RESULTS OF TESTS

The material is fairly hard, semistratified, slightly soapy clay which is dark gray in color, has an irregular conchoidal fracture, good plasticity over a satisfactory range, and requires 32.4 per cent water to develop its normal stiff working consistency. A medium bonding strength is indicated by a value of 225 pounds per square inch for the modulus of rupture. It dries fairly rapidly without difficulty under ordinary atmospheric conditions, scums somewhat, and has a shrinkage of 9.1 per cent. When slaked and washed on a 40-mesh sieve, 26.8 per cent residue remains, which consists largely of unslaked, original material containing considerable coarse pyrites. Treatment with hydrochloric acid causes no evolution of gas, indicating the absence of carbonates.

BURNING TEST

| Cone | Porosity per cent | Color | Hardness | Linear burning shrinkage per cent | Total linear shrinkage per cent |
|---|---|---|---|---|---|
| 05 | 1.3 | salmon | steel hard | 10.6 | 19.7 |
| 01 | 0.2 | brown | steel hard | 9.3 | 18.4 |
| 1 | 0.5 | brown | steel hard | 8.7 | 17.8 |
| 2 | 0.4 | brown | steel hard | 8.2 | 17.3 |
| 3 | 0.4 | brown | steel hard | 6.1 | 15.2 |
| 6 | bloated badly | | | | |

This material oxidizes with considerable difficulty. It is practically vitrified at the minimum temperature used. The shrinkages indicate a slight overburning until cone 3, when it is more definite, but it is very serious at cone 6.

Suggested uses: The presence of soluble salts and the poor oxidation conduct will probably restrict this to common brick, bloated aggregate, structural tile.

SAMPLE—W-3

Material—Underclay of Summum (No. 4) coal.

Thickness sampled—3½ feet.

Location—Outcrop along Illinois Waterway canal at Marseilles, SW. ¼ NW. ¼ NE. ¼ sec. 24, T. 33 N., R. 4 E. (Fall River Twp.), LaSalle County, Marseilles quadrangle.

Test by—Ceramic Engineering Dept., University of Illinois, for State Geological Survey.

RESULTS OF TESTS

Reaction for pyrites, present; color, bluish-gray; working property, good; drying conduct, satisfactory; volume shrinkage, 22.4 per cent; linear shrinkage, 7.0 per cent; water of plasticity, 23.9 per cent; shrinkage water, 11.2 per cent; pore water, 12.7 per cent; transverse strength test of unburned clay, none.

Burning Test

| Cone | Porosity per cent | Color | Hardness | Burning shrinkage | | Total linear shrinkage per cent |
|---|---|---|---|---|---|---|
| | | | | Volume per cent | Linear per cent | |
| 05 | 14.7 | Tan | Steel hard | 16.5 | 5.8 | 12.8 |
| 03 | 4.3 | Dirty gray | Steel hard | 20.8 | 7.5 | 14.5 |
| 01 | 3.6 | Gray | Steel hard | 14.8 | 5.2 | 12.2 |
| 2 | 4.3 | Gray | Steel hard | 9.4 | 2.2 | 10.2 |
| 4 | Stuck together and bloated | | | .... | .... | .... |

Oxidation conduct, very difficult to oxidize; soluble, sulfates present; overburned at cone 2.

Suggested uses: Common or face brick, quarry tile or crude products.

SAMPLE—W-1

Material—Canton shale.

Thickness sampled—58 feet.

Location—Outcrop on east side Walbridge Creek, NW. ¼ SW. ¼ SE. ¼ sec. 11, T. 33 N., R. 4 E. (Rutland Twp.), LaSalle County, Marseilles quadrangle.

Test by—Ceramic Engineering Dept., University of Illinois, for State Geological Survey.

RESULTS OF TESTS

Reaction for carbonates, none; color, brownish; working property, fair; conduct when flowing through a die, satisfactory; drying conduct, moderate amount of scum, no warping or cracking; volume shrinkage, 21.3 per cent; linear shrinkage, 6.6 per cent; water of plasticity, 31.4 per cent; shrinkage water, 12.2 per cent; pore water, 19.2 per cent; transverse strength of unburned clay with 50 per cent standard sand, 15 briquettes, modulus of rupture 271 lbs. per sq. in.

Burning Test

| Cone | Porosity per cent | Color | Hardness | Burning shrinkage | | Total linear shrinkage per cent |
|---|---|---|---|---|---|---|
| | | | | Volume per cent | Linear per cent | |
| 05 | 14.8 | Salmon | Almost steel hard | 27.5 | 10.2 | 16.8 |
| 03 | 0 | Good red | Steel hard | 34.9 | 13.3 | 19.9 |
| 01 | 0.4 | Good red | Steel hard | 31.5 | 11.9 | 18.5 |
| 2 | 0.3 | Good red | Steel hard | 28.5 | 10.6 | 17.2 |
| 3 | .... | Darker | .............. | .... | .... | .... |
| 4 | 1.3 | Reddish-brown | Steel hard | 21.4 | 7.7 | 14.3 |
| 6 | Stuck together and bloated | | .............. | .... | .... | .... |

Oxidation conduct, oxidizes easily at low temperature; soluble sulfates, present; warpage, none; color, good; range, fair; overburned at cone 4.

Suggested uses: Face brick; drain tile, roofing tile, quarry tile.

SAMPLE—25

Material—Shale over Herrin (No. 6) coal.

Company—Barr Brick Co. (now Purington Paving Brick Co.).

Location—One mile south of Streator in NW. ¼ NE. ¼ sec. 12, T. 30 N., R. 3 E. (Reading Twp.), Livingston County.

Source—Stull, R. T., and Hursh, R. K., Tests on clay materials available in Illinois coal mines: Illinois Geol. Survey Coop. Mining Series Bull. 18, 1917, pp. 36, 37.

RESULTS OF TESTS

Plasticity, fair; molding properties, good; drying properties, good; linear drying shrinkage, 4.71 per cent; volume drying shrinkage, 15.77 per cent; tempering water, 22.17 per cent.

BURNING TEST

| Cone | Porosity[a] per cent | Burning[a] shrinkage per cent |
|---|---|---|
| 010 | 30.5 | 0 |
| 08 | 28 | .5 |
| 06 | 26 | 2 |
| 04 | 25.5 | 2.5 |
| 02 | 23.5 | 3.5 |
| 1 | 15 | 5 |
| 3 | 13.5 | 7 |

Oxidation, complete in 1 hour; maximum safe burning temperature, above cone 3; when burned at cone 3, burning shrinkage, 6.82 per cent; total shrinkage 11.53 per cent; porosity, 13.70 per cent; fracture, stony; color, dark red; scums badly.

Possibilities: Common, front, and paving brick, hollow ware.

Precautions: For front brick barium salt should be added to overcome scumming.

[a] Estimated from graphic illustration.

SAMPLE—K-15

Material—Shale over Herrin (No. 6) coal.

Company—Barr Clay Co., (now Purington Paving Brick Co.).

Location—South of Streator, NW. ¼ NE. ¼ sec. 12, T. 30 N., R. 3 E. (Reading Twp.), Livingston County, Streator quadrangle.

Source—Rolfe, C. W., Purdy, R. C., Talbot, A. N., and Baker, I. O., Paving Brick and Paving Brick Clays of Illinois: Illinois Geological Survey Bull. 9, pp. 285-288, 1908.

RESULTS OF TESTS

Tensile strength of green clay, 5.876 kilos per sq. cm.; specific gravity, 2.65; porosity, 28.50 per cent; water of plasticity, 16.90 per cent.

BURNING TEST

| Cone | Porosity per cent | Specific gravity |
|---|---|---|
| 010 | 32.2 | 2.56 |
| 08 | 30.8 | 2.54 |
| 06 | 27.4 | 2.53 |
| 04 | 18.7 | 2.45 |
| 02 | 20.3 | 2.56 |
| 1 | 17.3 | 2.50 |
| 3 | 6.4 | 2.43 |
| 5 | 1.94 | 2.19 |
| 7 | 2.91 | 2.00 |

SAMPLE—205

Material—Underclay of Sparland (No. 7) coal.

Thickness sampled—6 feet.

Company—Streator Clay Products Co.

Location—Southeast of Streator, NW. ¼, NE. ¼ sec. 18, T. 30 N., R. 4 E. (Newtown Twp.), Livingston County, Streator quadrangle.

Collected by—R. E. Grim, State Geological Survey.

Test by—Ceramic Engineering Dept., University of Illinois, for State Geological Survey.

RESULTS OF TESTS

Color, dark gray; hardness, medium hard; working property, plastic material very soft and rather sticky, not readily wedged; water of plasticity, 30.8 per cent; transverse strength of unburned clay with 50 per cent standard sand, 10 briquettes, modulus of rupture 327 lbs. per sq. in.; same, without sand, 8 briquettes, 893 lbs. per sq. in.; slaking test, mixture 50 per cent flint, time 26.1 minutes; linear shrinkage, 12.7 per cent; volume shrinkage, 43.0 per cent.

BURNING TEST

| Cone | Porosity per cent | Color | Hardness | Burning shrinkage volume per cent | Total linear shrinkage per cent | Remarks |
|---|---|---|---|---|---|---|
| 012 | 27.1 | White-buff | ............... | 0.9 | 13.0 | |
| 08 | 21.4 | Buff | Steel-hard | 8.2 | 15.5 | |
| 02 | 19.2 | Cream | ............... | 10.6 | 16.4 | |
| 1 | 16.0 | Cream | ............... | 14.3 | 17.7 | |
| 4 | 12.3 | Light-buff | ............... | 15.2 | 18.0 | |
| 7 | 7.6 | Dirty-buff | ............... | 17.9 | 19.0 | fire cracked |
| 8 | 2.5 | Light-gray | ............... | 18.3 | 19.2 | |
| 10 | 1.1 | Buff-gray | ............... | 19.1 | 19.5 | |

Fusion Test P.C.E.—Cone 20

# APPENDIX K

# COLLECTING LOCALITIES

By
H. B. Willman

The following localities are the best for collecting rocks, minerals, and fossils in the Marseilles-Ottawa-Streator area. Additional localities may be determined from the geologic sections described in appendix A.

## SEDIMENTARY ROCKS[1]

### Unconsolidated

#### Glacial and Recent materials

*Clay.*—See till below.

*Silt.*—(1) Loessial silt.—Road-cuts in sec. 35, T. 33 N., R. 2 E. (Deer Park Twp.), Ottawa quadrangle.

(2) Lacustrine silt.—Geologic sections 38, 48, 49, and 68.

*Sand.*—Sand and gravel pits (pls. 4-6) and geologic sections 47, 48, and 86.

*Gravel.*—Sand and gravel pits (pls. 4-6) and geologic sections 39, 47, 48, 68, 70, and 92.

*Till.*—Nearly all road-cuts in the upland area and geologic sections 39, 48, 68, 78, 85, and 93.

### Consolidated

#### Bedrock materials

*Underclay.*—Geologic sections 1, 3, 5, 6, 10, 19, 22, and 27.

*Shale.*—(1) Gray shale—Geologic sections 1, 3, 6, 9, 14, and 21.

(2) Soft black shale—Geologic sections 1, 8, and 17.

(3) Hard black massive shale—Geologic sections 12, 14, and 17.

(4) Hard black sheety shale ("slate")—Geologic sections 1, 3, 5, 8, 13, and 14.

(5) Red and green shales—Geologic sections 11, 12, 29, and 33.

*Siltstone.*—Beds in Pennsylvanian sandstones, especially the Pleasantview sandstone—Geologic sections 3, 5, 7, and 13.

*Sandstone.*—(1) St. Peter sandstone—Many places along Illinois Valley west of Ottawa and along Fox Valley (pls. 1, 2).

(2) Pennsylvanian sandstones—Illinois Valley bluffs near Marseilles and Seneca and geologic sections 1, 9, 14, 20, and 28.

*Conglomerate.*—Covel conglomerate—Geologic sections 1, 3, 9, 11, and 14.

*Limestone and dolomite.*—

Pennsylvanian limestones—Geologic sections 1, 5, 8, 12, and 14.

Conglomeratic limestone—Geologic section 23.

Brecciated limestone—Geologic section 3.

Decorah and Platteville limestone and dolomite. —Along Covel Creek in the SE. ¼ sec. 21, T. 33 N., R. 3 E. (South Ottawa Twp.), Ottawa quadrangle; along French canyon in Starved Rock State Park in the SW. ¼ sec. 22, T. 33 N., R. 2 E. (Deer Park Twp.), Ottawa quadrangle; and along Vermilion River at Lowell in the SE. ¼ sec. 8, T. 32 N., R. 2 E. (Vermilion Twp.), LaSalle quadrangle.

*Coal.*—Mines (pls. 4-6) and geologic sections 6, 15, 19, and 28.

*Chert.*—Nodules and lenticular bands in the Decorah and Platteville formations (see above).

## IGNEOUS AND METAMORPHIC ROCKS[2]

Pebbles, cobbles, and boulders of granite, diorite, peridotite, basalt, schist, greenstone, gneiss, and quartzite common, and others less common, in glacial drift (see till) along nearly all the streams of the area and in the gravel pits (pls. 4-6).

## MINERALS

*Calcite* (calcium carbonate).—Crystals in veins, pockets, geodes, etc., in the Brereton limestone along a stream south of the Streator Clay Products Co. plant, 1½ miles southeast of Streator, and in the Platteville limestone in the SW. ¼ NW. ¼ SE. ¼ sec. 16, T. 33 N., R. 3 E. (Ottawa Twp.), Ottawa quadrangle.

*Dolomite* (calcium and magnesium carbonate).—Small rhombic brown-weathering crystals in the Platteville and Decorah formations (see above).

*Gypsum* (hydrated calcium sulphate).—A 1-inch band of transparent acicular crystals along the base of the LaSalle (No. 2) coal in the pit of the Chicago Retort and Firebrick Co., east of Ottawa; large individual crystals on the surface of coal mine waste piles in the northeast part of Ottawa in the SW. ¼ SE. ¼ NW. ¼ sec. 1, T. 33 N., R. 3 E. (Ottawa Twp.), Ottawa quadrangle; and small crystals along bedding-planes in the black sheety shales (see above).

*Illite* (hydrated aluminium silicate).—Microscopic grains comprising the most abundant clay mineral in the Pennsylvanian shales.

*Kaolinite* (hydrated aluminium silicate).—Microscopic grains comprising the most abundant clay mineral in the underclay of the LaSalle (No. 2) coal.

*Limonite* (hydrated iron oxide).—Common brown or rust-colored stain on the surface of many weathered rocks; common deposit along streams which drain coal mines, such as the one on the east side of Vermilion River north of the railroad in the NE. ¼ SW. ¼ NW. ¼ sec. 26, T. 31 N., R. 3 E. (Bruce Twp.), Streator quadrangle.

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[1]The classification of sedimentary rocks used in this report is given in appendix D, table 1.

[2]Ekblaw, George E., and Carroll, D. L., Typical rocks and minerals in Illinois: Illinois Geol. Survey, Educational Series No. 3, 1931.

*Muscovite* (sodium and potassium aluminium silicate).—Small mica flakes abundant in the Pennsylvanian sandstones, especially along bedding-planes.

*Pickeringite* (hydrated magnesium aluminium sulphate, "magnesium alum").—White powder or white nodules on surface of St. Peter sandstone along some of the canyons in Starved Rock State Park, especially along the west side of LaSalle Canyon below the falls; readily soluble in water, consequently it varies greatly in abundance, frequently disappearing completely during wet periods.

*Pyrite* (iron sulphide, "fool's gold").—Brassy-yellow mineral common in the coals, usually as thin lenses along the bedding planes; individual crystals and aggregates especially abundant in the lower 5 feet of the Francis Creek shale which is abundant in the waste piles at the clay mines and strip coal mines in the Ottawa area (pl. 5); crystals common in the clay below the LaSalle (No. 2) coal (geol. secs. 6 and 10), and in the Covel Conglomerate (geol. secs. 1, 3, 9, 11, and 14).

*Quartz* (silica).—Grains in all sandstones and locally thin veins in various bedrock formations.

*Siderite* (iron carbonate).—Discoidal concretions which grade from slightly calcareous sideritic to dominantly limestone concretions, in many of the Pennsylvanian shales (geol. secs. 1, 3, 7, 12, 13, and 41).

Many other minerals may be found in pebbles in the glacial drift.

## FOSSILS

(See Appendix G and plate 30)

*Ordovician fossils.*—Platteville and Decorah limestone along Vermilion River at Lowell; Platteville limestone along Covel Creek two miles southwest of Ottawa, in the SE. ¼ sec. 21, T. 33 N., R. 3 E. (South Ottawa Twp.), Ottawa quadrangle.

*Pennsylvanian fossils.*

Gastropods—Base of the Canton shale in pit at abandoned brickyards, half a mile northwest of Ottawa, in the SW. ¼ NE. ¼ SW. ¼ sec. 3, T. 33 N., R. 3 E. (Ottawa Twp.), Ottawa quadrangle; along Covel Creek, three miles south of Ottawa, near the center of the south line of sec. 26, T. 33 N., R. 3 E. (South Ottawa Twp.), Ottawa quadrangle; and on east side of Vermilion River, four miles southwest of Grand Ridge, in the NW. ¼ NW. ¼ sec. 32, T. 32 N., R. 3 E. (Farm Ridge Twp.), Streator quadrangle.

Brachiopods—Brereton limestone, along stream south of the Streator Clay Products Co. plant in the NW. ¼ NW. ¼ sec. 7, T. 30 N., R. 4 E. (Newtown Twp.), Streator quadrangle. In Hanover limestone, along stream southeast of Vermilionville, in the NW. ¼ NE. ¼ SW. ¼ sec. 10, T. 32 N., R. 2 E. (Deer Park Twp.), Ottawa quadrangle.

Pelecypods—*Aviculopecten rectilaterarius* abundant in the lower few inches of the St. David black, "slaty" shale (geol. secs. 1, 3-5, 7-9, and 11-14).

Plants—Interbedded gray and black shale below Herrin (No. 6) coal, on the east side of Vermilion River in the SE. ¼ NW. ¼ NW. ¼ sec. 26, T. 31 N., R. 3 E. (Bruce Twp.), Streator quadrangle.

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